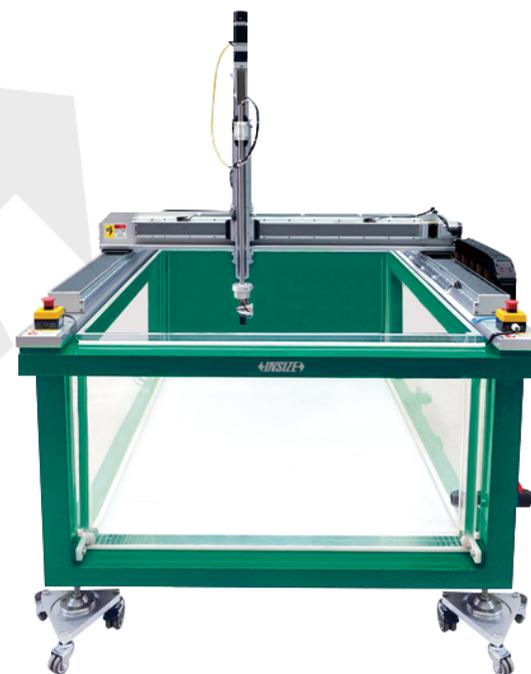




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**UFD-CW650
ULTRASONIC FLOOD DETECTION SYSTEM
OPERATION MANUAL**



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1. INTRODUCTION

UTwin is a 32 bit WINDOWS, Data Acquisition, Imaging and Replay program capable of running for all ULTRAPAC IIT™ ultrasonic nondestructive testing systems. UTwin uses full WINDOWS resources including: Setting of any WINDOWS available screen resolutions, Printing, Networking, Multi-Tasking, Multi-Threading, etc. It is capable of operating in WINDOWS 2000/XP operating systems. UTwin is fully compatible with NDT Automation's ULTRAWIN™ data files and data files from Pocket UT, a handheld UT system capable of processing and storing A-Scan's, B-Scan's, & C-Scan's. This allows you to replay and analyze all your previously collected data files and maintaining compatibility with present and future NDT Automation systems. UTwin is easy to learn, operate and use. The software has all the acquisition, graphing and analysis capabilities that you have come to expect in your UT system, plus many more new and enhanced features to ease your data analysis and visualization tasks.

Some of the general UT display and analysis capabilities found in UTwin's includes the following: UTwin provides a framework for easily adding graphs and graph screens to the main system WINDOW. UTwin has various user selectable tool bars including: Setup icon toolbar, acquisition control, status toolbar. UTwin has many built in, enhanced features including: Graph zooming and panning, more flexible graph setup, and more graphs. Printing capabilities include: Print a graph, a screen or multiple screens to a WINDOWS or network printer, to the clipboard or to a JPEG file.

Some of UTwin's graphing capabilities include:

- Exceptional 2D and 3D graphing capabilities. Multiple graphs can be displayed on a screen, limited only by the resolution of the screen itself.
- Graphs are individually sizable on a screen, making for a very flexible arrangement. The user can set up one (or more) large graphs for visualization with multiple supporting small graphs alongside or around the main ones.
- Multiple Graphs are arranged on a screen. Multiple screens can be setup, each accessible by selecting a user labeled tab. Therefore, a user can set themes for screen layout (e.g. A-Scan, Feature monitoring, B-Scan, Real-time C-scan, Replay analysis, themes to name a few)
- Many different types of graphs can be set up including: A-Scan, Zoomed A-Scan, Spectrum, 2D C-Scan image, 3D C-Scan image, multiple plots on a single graph with coloring options, etc.
- All graphs can easily be enlarged to full screen (maximized) by the touch of a button.
- All graphs have full Cursor Readout capability, either one or double cursors.
- All graphs (2-D and 3-D included) can be infinitely zoomed and panned for close-up analysis.

In addition UTwin™ is packed with features which include:

- Flexible hardware configuration
 - 1) Multiple pulser/receiver (P/R) support including NDT Automations plug-in PC boards including IPR-100 and AD-IPR1210. Also external Pulser/Receiver's are supported including PR-60 and others which can be software controlled via a serial port connection.
 - 2) Multiple Analog to Digital (A/D) converter support including NDT Automations PCI based plug-in cards AD-1210 PC, AD-81G, AD-81.5G and AD-82G with resolutions up to 16 bits.
 - 3) Multiple axis scanner support (stepper or servo motor) using NDT Automations PCI-SMC4/8, with control of 4 or optionally 8 axes in one PCI card.
- Eight axes motion control (X,Y, Z axes and turntable axis) with or without encoders and optional motorized manipulator support.
- Real time display and acquisition of A-Scan, B-Scan and C-Scan
- Multiple gate settings (currently up to 4 for standard UTwin, nonstandard system can provide even more)
- Powerful post-processing features like zoom, cursors, etc.
- Easy file handling capabilities
- Optional features include:

- 1) RF Waveform storage and replay
- 2) Weld Analysis
- 3) TOFD (Time of Flight Diffraction)
- 4) 3D C-Scan
- 5) Statistics Analysis
- 6) Cluster analysis
- 7) Chain Scan
- 8) Multi-Channel C-Scan capability
- 9) Contour following
- 10) Auto Report Option

Given the features described above, UTwin™ is ideal software for various industrial applications and Research/Development purposes.

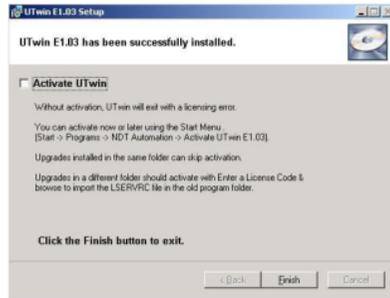


Figure 1.1: Installation Screen.

1.1 System Requirements

UTwin software requires a ULTRAPAC™ computerized system with a CPU speed of 2 GHz or higher. Although lower system computer configurations will operate UTwin, it is recommended that a 2 GHz processor, 1 GBYTE RAM, 60 gigabyte hard disk and 17" display monitor with 1280 x 1024 resolution be utilized. Certainly, higher performance computers (including dual core CPU's) will provide even more performance and are encouraged. The UTwin program runs under WINDOWS 2000/XP operating systems. These days this type of computer power is easily available at low cost. Please consult the factory if your computer is below these standards.

If UTwin is being installed explicitly for replay and analysis, it is also recommended to use a similar computer base as that described above.

1.2 Software Installation

The UTwin program is generally pre-installed on the UT system computer from the factory. In special instances, such as software upgrades, however, you will need to perform the installation yourself from the supplied CD. You cannot run UTwin directly from the distribution CD because the files on the disk are compressed and security protected.

If you are installing UTwin yourself, you will need to follow the simple installation instructions below. Due to the built-in software security features of this software, part of the installation process requires you to obtain an activation code from NDT Automation. The process is simple, you will be prompted to either call the factory or email the factory to obtain your security activation code, which you will enter to complete the installation process. This is all explained below.

To fully install UTwin, you must perform the following steps, after you have exited all running applications.

1. Install all hardware (such as AD-IPR-1210 board, PCI-SMC4/8 board, PCI-SMC4/8 Stepper Motor controller board) and drivers.
2. Run SETUP.EXE from the root directory of the UTwin installation CD disk.
3. Activate the software using one of two methods:
 - a) On the last screen of the setup program there is a checkbox for product activation. If this is checked when you press finish it will run the activator program automatically.
 - b) To run the activator program manually it can be found at:
Start Menu-->Programs-->NDT Automation-->Activate UTwin

Each step in the process is described below.

1.2.1 Installing and Upgrading UTwin from the installation CD:

Insert the UTwin installation CD into your UT System (or PC computer). Using your mouse or keyboard, select:

Start → **Run** and type or select **D:\setup.exe**
(If your CD is other than drive D: enter that letter).

Upon executing, you will follow a typical Windows installation process. Select all the default directories (highly recommended but not mandatory) if desired. Upon completion, of the installation, you will see the "Setup Complete" window as shown in Figure 1.1. Note the comments and remaining steps that must be carried out. In most instances you will need to Activate UTwin before you can run it. This process can be started automatically by checking the 'Activate UTwin' checkbox before clicking Finish.

If UTwin has already been installed and you are upgrading it to a newer version, simply install the newer version to the same directory where the old version has been installed. Then all system and project settings in your old version are automatically transferred to the new version. The license file is also retained and there is no need to activate the program again. In most cases, to update UTwin, you can simply replace the old UTwin.exe file with the newer one, which you can find in your installation CD.

1.2.2 Activate the UTwin software using the Start Menu option

To manually activate the UTwin software, you must first select the "Activate UTwin" program. Do this by using your mouse to select the following:

Start → **Programs** → **NDT Automation** → **Activate UTwin**

This brings up the UTwin Activation screen as shown in Figure 1.2. Selecting "Continue" will bring up the "Activation method selection" screen, shown in Figure 1.3.

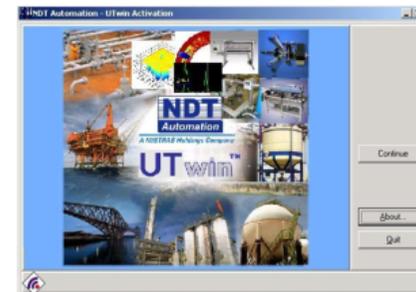


Figure 1.2: Activation Opening Screen.

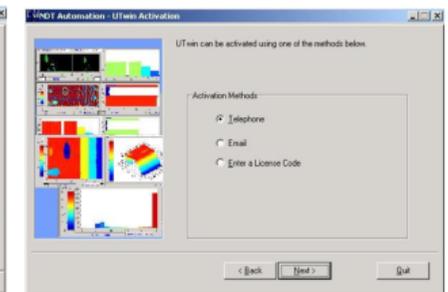


Figure 1.3: Choose Activation Method.

You have several methods in which to Activate UTwin _ "Telephone", "Email" and "Enter a License Code".

If you have a "Hardware Security Key" then much of this process has already been completed for you. A License Code has already been generated for you and is stored as a file ("lservr") on your "Hardware Security Key" CD. Use the "Enter a License Code" method to activate UTwin.

If you do not have a “Hardware Security Key” then you will need to obtain a license code from PAC customer service. UTwin can be activated in this manner through either the “Telephone” or “Email” methods below.

You can “activate by telephone”. If this method is selected, you will see a menu as shown in Figure 1.4 which provides you with a telephone number to Customer Service who will help you and provide you with a License code that you can enter in while on the phone. You can “activate by email”.

Upon selecting this choice you will see the screen as shown in Figure 1.5.

Your system will need to be able to access the internet to use this option. If it is internet ready, this is the easiest option to use. Just fill out all the information and press “Send Email”. Your activation information will automatically be sent to customerservice@pacndt.com and your license code will be sent back to you as an email attachment.

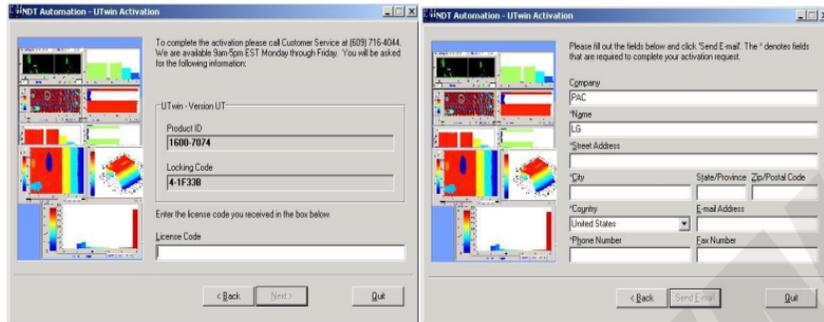


Figure 1.4: Activate by Telephone.

Figure 1.5: Activate by e-mail

The last way to activate UTwin is by entering a license code. This method is selected once you receive your Email with the License Code or if you have written down the license code and wish to install it. Upon selecting this activation method, you will see the screen as shown in Figure 1.6. This is a little different than that shown in Figure 1.4 as you can either enter a number directly or you can choose the file folder just to the right of the License Code text entry box. Using the file to automatically enter the License Code is preferred to avoid making entry mistakes with the long license code number. Just select the file folder to enter a file. A screen as shown in Figure 1.7 appears in which to select your license code file. Find the license file with the name LSERVRC and select it and the code will be entered automatically.



Figure 1.6: Enter License Code Screen.

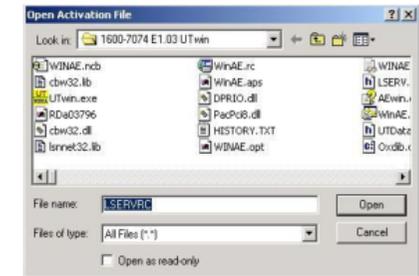


Figure 1.7: Selecting the LSERVRC License File

Once the License code is entered using any of the above methods, just press NEXT to continue and complete the activation process. This is it. UTwin is now installed.

UTwin is now installed and activated. Your UTwin software is ready to run by selecting:

Start Programs NDT Automation UTwin

If you wish to run the UTwin software in acquisition, you need to make sure that your UT board drivers have been installed. Please note the instructions below. The example UT board driver installation is shown below.

1.2.3 Installing the Data Acquisition Board driver if you are doing acquisition

The various NDT Automation Data Acquisition Boards (ADIPR1210, AD81G, PCI8 etc) and SMC4/8 motion control Cards (ISA and PCI) require a driver in order to function properly in Windows.

Normally, when Windows is first booted after installing the card it will prompt for a driver for it. Point Windows to the appropriate driver folder on the CD and follow the instructions.

The driver folders are located on the CD at the following locations:

- Drivers\.

If for some reason you need to install a driver manually then read the document (drivers.doc or readme.txt) found in the appropriate driver folder. Use the procedures described there only if the above automatic driver installation does not work. It is not normally required to install the driver this way. But if problems arise, that is how to do it.

1.2.4 Warning Notes

Please note the following warnings:

1. If the software is not activated before attempting to run it, the software terminates with a message to contact customer service for the proper activation code.
2. If the entire system came from NDT Automation, the drivers and software are pre-installed at the factory.

1.2.5 Installing a Shortcut Icon for UTwin on the Desktop

Once the UTwin software installed as described in the previous sections, and assuming that all the default selections have been selected, the software can be started by the following mouse operated (activated by pressing the left mouse button) sequence;

A UTwin Icon should automatically be created after installation. If not, a UTwin desktop Icon can easily be created by performing the same sequence above except pressing the right mouse button when pointing to UTwin. Upon doing this a menu will appear. You can either select "create shortcut" (which will create a second copy of the UTwin program title) and drag it to the desktop or you can select "Send to", then select the "desktop (create shortcut)" menu button which will place this extra copy directly on the desktop. Once created, the Icon title can be modified by left-clicking on the title. Now the program can be run directly by double clicking the UTwin Icon on the desktop.

1.2.6 Upgrading UTwin Software Using the Existing License Code

Here's how to upgrade UTwin without needing to re-activate:

A UTwin license is stored as a file, with filename, "lserverc" in the same folder as the executable (UTwin.exe). It is created during the activation process and is NOT deleted during an uninstall of UTwin. This file will only work on the computer for which it was created.

If you want to upgrade to a new version of UTwin, simply install it in the same folder as the old version (This will overwrite the old version, but will leave any user-created data/project files unchanged). The license file will remain untouched and you won't have to re-activate. If you need to install to a different folder then you can manually move this file to the new location or run the activator again and reference the indicated file.

2. UTwin PROJECT (.pro) FILES AND DATA FILES

This section discusses the various file types associated with UTwin. The most important files you will be working with everyday with UTwin are the Setup Files (called Project files in UTwin) and the Data files. Your working copy of UTwin will have examples of both these layout files and test data files. You will be creating, using and modifying these files in the course of your work.

The initialization or setup files, referred to as "Project" files, distinguished by the suffix .PRO, hold all UT test setup information for the UTwin software. A .PRO file stores the hardware setup and graph setup. All system related information such as type of A/D and motion control boards, motor resolution, user interface language, units, etc., are stored in a default system setup file called UTWin.ini in the same directory as the executable file UTWin.exe. The UTWin.ini has been setup up at the factory based on specific UT systems and should not be revised or deleted. If this file has been accidentally revised or deleted, you can find this file in your installation CD and copy it back to the same directory as the executable file UTWin.exe.

A .PRO file can be loaded from disk by means of the "Open Project" option in the "File" Menu of the UTwin program. Once loaded, all the initialization information from the project file immediately becomes effective for system operation. A .PRO file is written to disk by means of the "Save Project" or "Save Project As" option in the File Setup menu. All the initialization information currently established in the system is written to the file. A .PRO file can have any name followed by the .PRO extension.

There is one special .PRO file known as the Autoload file. It is distinguished by the special name UTWin.PRO. The Autoload file, when present, is automatically read from disk when the UTwin program begins to run. If the Autoload file is not present, the system is set up with default values held in the UTwin program itself. The Autoload file is a convenience feature to speed your work.

UT Test Data Files are identified by the various filename extension listed below. You may specify any name for a data file using standard Windows file naming conventions.

File types:

*.CSC file:	C-scan data file. This file is saved in binary format. It contains the setup part and the feature data.
*.BSC file	B-scan data file. This file is saved in binary format. It contains the setup part and the feature data.
*.CSV file	data files for A-Scan waveform, spectrum, C- and B-Scan in ASCII format.

Project and data files may be written to any disk drive and any specified subdirectory. A good practice is to save both .PRO files and data files to the same drive and subdirectory, keeping related test files together. It is also a good practice to name the files very similar as this will help keep the project files organized with the data files.

There has been an intentional name and file-extension change from the "Setup" (.SET) file of the "Legacy" ULTRAWIN programs to the "Project" (.PRO) file for setup files utilized by UTwin. UTwin can open and replay data files generated by ULTRAWIN. But ULTRAWIN cannot open and replay UTwin data files.

3. OPERATING UTwin - GENERAL

The purpose of this section is to provide a quick software operational run-through, to provide a familiarization with operating and using UTwin. This is the most important part of this UTwin software user's manual as it will provide a view of the important screens and commands necessary to get UTwin setup, and running in both Replay and Acquisition modes.

3.1 Starting UTwin

The first step in the process of using UTwin is booting up the program on your UT system. As the UTwin program is a standard Windows program, it is started in the same way as any other WINDOWS program. This is accomplished either by using the "Start" command or by selecting the UTwin Icon from the WINDOWS desktop.

It is assumed that the ULTRAPAC computer is booted up and in its opening screen which is the desktop layout showing all the available program icons to select. If the NDT Automation UTwin icon (as shown on the right) is on the desktop, all you need to do is select this by double clicking the left mouse button, once the mouse is positioned over the icon. If the icon is not on the desktop you can create the shortcut by referring to section 1.2.5.



Alternatively you can start UTwin by selecting the following sequence starting with the Start menu at the bottom left side of the screen:

Start Programs NDT Automation UTwin

The boot-up sequence for UTwin starts by loading the executable program UTwin.exe. Once UTwin is loaded, the program searches the startup directory for the default Project (setup file) called "UTwin.pro". Upon finding this file, UTwin loads it and becomes fully configured and ready to run in accordance with the setup information in that default UTwin.pro file. If UTwin.pro is not found, UTwin chooses a common default starting setup that is ready for use. In either case a UTwin startup screen similar to Figure 3.1 will appear.

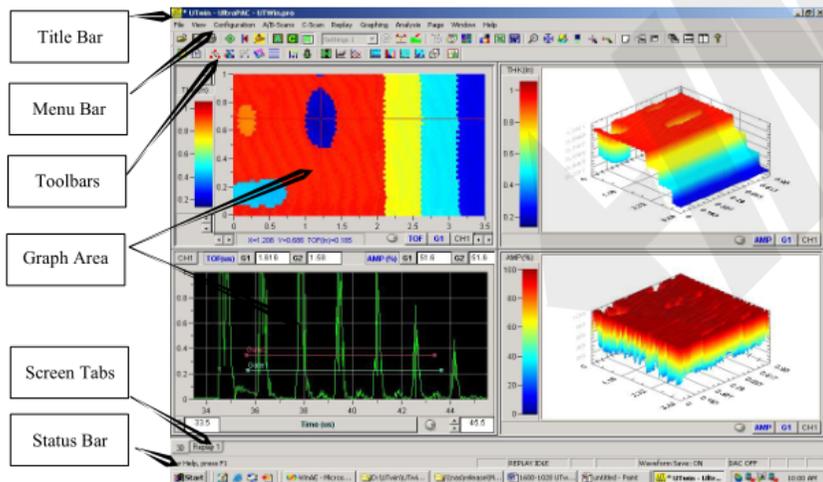


Figure 3.1: A typical UTwin User Interface.

3.2 UTwin Screen Layout Familiarization

Figure 3.1 shows a typical 4-screen layout for UTwin. Above and below the graph area are various informational, status and setup toolbars. Each bar is labeled with a name. Depending on the preferences selected and installed options for your program, you may have other toolbars or be missing some. The "View" menu in the main menu bar, controls which bars are on or off. The following is a short description of each area identified on the UTwin screen. This section will get you familiar with the layout and the overall function. Further chapters will provide detailed insight into the use of each of these functions.

Title Bar: This is a typical WINDOWS Title Bar with all the standard capabilities. At the leftmost position is the UTwin Logo Icon from which you can manage the UTwin program with functions such as minimize, restore, maximize, move, size or Close the program altogether. At the far right are the application buttons for Minimize, Restore and Close. Back on the right hand side next to the UTwin Logo Icon is the program name (in this case it is UTwin - ULTRAPAC) and next to that is the name of the current project file being used by the program. If an asterisk (*) appears next to the file name, it indicates that one or more settings have been changed since the last time the layout file was loaded or saved.

Main Menu Bar: The main menu bar provides a series of text commands running across the line, including: File, View, Configuration, A-Scan, C-Scan, Replay, Analysis, Page, Window, and Help. Most of these items contain pull-down sub-menus of their own, many of which in turn contain graphical dialog boxes and prompts of their own. You narrow down the range of choices until you arrive at the specific choice you want.

To display a pull-down sub-menu from a main menu entry, simply move the mouse pointer to the name of the menu item on the menu bar and click the left mouse button. This process is known as "clicking" (or "left-clicking") on an item, and will herein be referred to as such. To use the keyboard, simultaneously press the ALT key and the underlined letter of the menu item name at the same time. Once you have opened a pull-down menu item from the main menu, you can use the left and right arrow keys to move through each entry, allowing you to see the pull-down menu for each main menu entry. You can also use the up and down arrow keys to move through each selection of the pull-down menu. To select an item from a pull-down sub-menu, click on the desired action, or use the up and down arrow keys to select an action, and then press ENTER. Pressing the underlined letter of a menu item will also select that item. If an item in the pull-down menu appears "grayed out," this action is not available in the current software or at the current time. Use the <ESC> key to remove the pull-down menu display.

Most of the selections in the pull-down sub-menus will display a dialog box requesting information necessary to carry out the command you requested. A dialog box contains areas where you enter information, select options or commands, or activate controls to execute or cancel a command. There are several types of boxes and buttons available within a dialog box. These boxes and buttons are described briefly below and will be described in further detail in subsequent sections of this manual. It is important that you be familiar with dialog boxes and be comfortable using them, for they are the means by which most functions are carried out in the UTwin software.

Icon Toolbars: Many of the menu items accessible from the Main pull-down menus can also be accessed by use of the Icon Toolbar just below it. Figure 3.2 shows the Icon toolbars.



Figure 3.2: Icon Toolbars

To determine the function of any of the Icon's simply move the mouse cursor over top of the desired icon. Upon resting there for approximately 1 second the Icon's function will appear. To select an icon as a shortcut command, simply click on it with the left mouse button.

Graph Area: The graph area is the most important area of the screen. This is where the UT information in the form of graphs and tables appear regarding the UT examination status. The graph area can be set up in many ways with a minimum of 1 graph to a maximum only limited by the graph visibility. More about the graph setup, functionality and flexibility will be discussed later in the Graph setup menu.

Screen Page Tabs: UTwin can show many different graph screens, these are called screen or graph “Pages”. Accessibility to viewing any screen is provided via the Page tabs located just below the graph area. The Page tabs can be named to be synonymous with the graph theme as shown in Figure 3.1 with the 4 Page tab names, 4C, Statistics, 3D and b-Scan. Using the right mouse button and clicking on a page will display a ‘context’ menu from which pages can be added, inserted, deleted or renamed. The context menu is also a quick way to add new graphs and close existing graphs.

Status Bar: The Status bar provides useful information regarding UTwin and test status. On the left is a Text bar providing status and help information regarding the functions being carried out.

3.3 Navigating the UTwin Menus

This section provides a detailed reference of UTwin’s major menu items and dialog boxes. The first time through, we suggest you just look at the menus (to get familiar with them) and use the setups provided with your UTwin installation, that have been predefined by NDT Automation; later, you can make your own choices within the menus to control system operation.

From the typical screen (Figure 3.1), pay attention to the Main Menu Bar near the top of the screen. This specific area is shown again below. Each main menu item will be described. This brief introduction to navigating the menus is provided in order to get ready for guiding the user in the sequence of starting and replaying a test.



Figure 3.3: Main Menus and Toolbars

3.3.1 File Menu

3.3.1.1 New Project

The ‘New Project’ menu item is used to remove all graphs and pages and restore the graph layout to a default setting of one page and one simple graph. This command does not alter any other settings.

3.3.1.2 Open Project...

The ‘Open Project...’ menu item is used to load a specified project file’s setup information into UTwin.

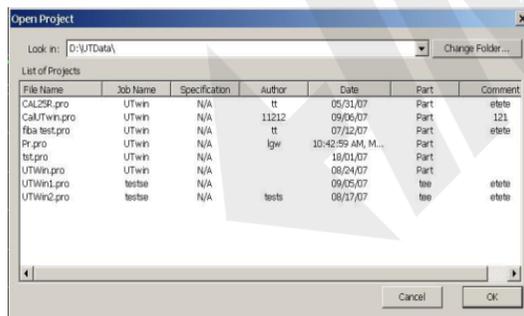


Figure 3.4: Open Project...

3.3.1.3 Save Project As...

The ‘Save Project...’ and ‘Save Project As...’ menu items are used to save the setup information in UTwin to a specified project file. When the ‘Save Project As...’ item is clicked the ‘Save As’ dialog is displayed. Here you can enter a new layout filename to create or an existing one to overwrite. Once this is done you will see the project filename you entered on the upper left corner of the screen. You can use ‘Save Project...’ from then on to update the file with any changes you have made since you have last saved.



Figure 3.5: Save Project As...

3.3.1.4 Replay Data

The ‘Replay Data’ menu items opens a dialog box to select a data file for replaying. After the data file has been opened, the program will automatically switch to replay mode. You can also start replaying by selecting menu items under the ‘Replay’ main menu. See section 6 for more details regarding replaying data.

3.3.1.5 Save Scanning Data As...

The ‘Save Scanning Data As...’ item is used to facilitate saving data in binary format after finishing a B or C-Scan. In B-Scan mode, select this menu item to save data in .bsc binary format. In C-Scan mode, select this menu item to save data in .csc binary format.

3.3.1.6 Save Graph Data As...

The ‘Save Graph Data As...’ item is used to save data or an image associated with a graph. Selecting this menu item is equivalent to clicking the ‘Save’ button at the bottom of each graph. Selecting this menu item will activate data saving for the current active graph (the last-selected (clicked by mouse) graph). If you want to save data for a specific graph, you first need to select it (click any place in the graph) and then select this menu item or simply click the Save button at the bottom of the graph. After the Save dialog is opened, you can select the data saving format from the “Save as type” list box at the bottom of the dialog. You can save the image of a graph in Jpeg, Bitmap and Tiff formats and save the data in a graph in binary (.bsc, .csc, .bin) and ASCII (.csv) formats.

3.3.1.7 Export Scanning ASCII Waveform and Export Scanning ASCII Feature

Select this menu item to export features or RF waveforms saved during B- or C-scan, in ASCII format. RF waveforms associated with different channels are saved in different files. The file name for channel ## are saved in XXXX-CH##.csv, where XXXX is your input file name.

For B-Scan, each column in the saved ASCII data file represents one acquired waveform.

For C-Scan, each row contains index number, scanning number and corresponding waveform at that scanning position.

3.3.1.8 Project Manager

The 'Project Manager' menu item opens a dialog box of the same name. In this dialog, you also can specify the job name, inspector, sample batch name and sample serial#. In the project type box, you can specify the project's purpose as calibration or testing. For a testing project, the corresponding calibration project file can be inputted. In this case, during testing, the calibration project will be automatically loaded when calibration is required.

Click the 'Additional Project Info' to open the 'Additional Project Information' dialog shown in Figure 3.7. In this dialog, more parameters such as company, location, et al. can be specified.

For cylinder inspection systems, the 'Cylinder Inspection Info' button is enabled and click this button to setup more information related to cylinder inspection.

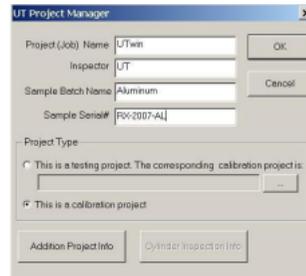


Figure 3.6: Project Manager

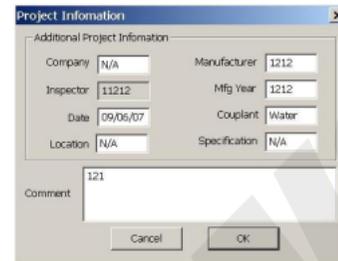


Figure 3.7: Additional Project Settings.



Figure 3.8: User Manager.

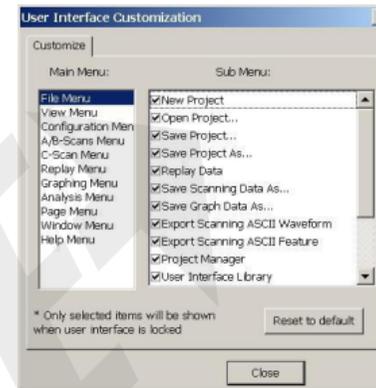


Figure 3.9: User Interface Customization.

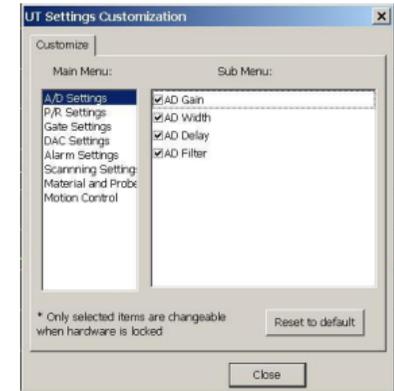


Figure 3.10: UT Settings customization.

3.3.1.9 User Manager

User Manager is used for supervisor mode. The 'User Manager' menu item opens the Settings for User Interface dialog. In this dialog, you can input your user name and password and configure your user interface.

Check the 'Lock selected user interface settings' to customize the user interface. Click the corresponding 'Details...' button to open the 'User Interface Customize' dialog shown in Figure 3.9. In this dialog, all menu items are displayed in check box lists. Check these boxes to turn menu items and their corresponding toolbar icons visible or invisible.

Check the 'Lock selected hardware settings' to enable or disable a given hardware parameter. Click the corresponding 'Details...' button to open the 'UT Settings Customize' dialog shown in Figure 3.10. In this dialog, you can specify these parameters, which operators cannot modify (disabled).

Password protected configuration doesn't allows other users to access menus which has been locked. See Section 7.1 for details.

3.3.1.10 User Interface Library

UTwin doesn't have a "standard" user interface, but it provides users very powerful and flexible tools to create their own graphic layout based on their applications. To facilitate the user interface creation, UTwin provides an editable library of all typical user interfaces for various applications. Click the 'User Interface Library' to open the List of Saved User Interface dialog. All saved user interfaces (graphic pages) are displayed in a list box (*Note: the user interface list depends on the current operation modes: A-Scan, C-Scan, and Replay*). You can select any page and insert it to your current application or replace your current page. The user interface list is editable. You can add your current page to the list or delete the select page.

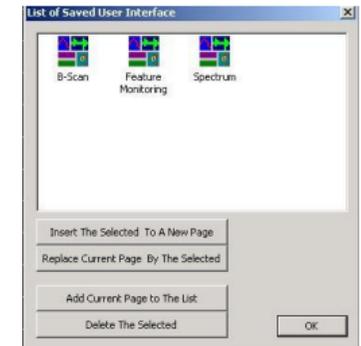


Figure 3.11: User Interface Library.

3.3.1.11 Print Page(s)/Print Graph...

The 'Print Page(s)...' and 'Print Graph...' menu items are used to print a graph or multiple pages of graphs. 'Print Graph...' is used to send the currently selected graph to the printer, zoomed as much as possible while still retaining aspect ratio. 'Print Page(s)...' is used to send a selection of pages to the printer one page at a time; each page zoomed as much as possible while still retaining aspect ratio. You can select 'All pages' or a range of pages.



Figure 3.12: Print...

When printing a graph, the 'Print Size Setup' dialog will appear after you select 'OK' in the 'Print' dialog. In the 'Printing Size Setup' dialog, you can specify the width and height of the printed image. For C-scan images, the default width and height are the actual scanning size. In the 'Comment' box, you can write some text regarding the graph and it will be printed at the bottom of the graph

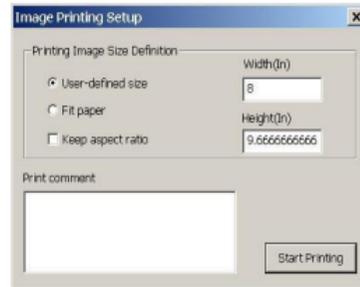


Figure 3.13: Printing Size Setup.

3.3.1.12 Export to JPG...

'Export to JPG...' is used to save pages as JPEG files in the same way that 'Print Page(s)...' sends pages to the printer. Here you enter a base filename and a destination folder. Each page will be saved as a separate JPEG file with its name formed from the combination of the base name and the page's title. e.g. If you had 2 pages named 'waveforms' and 'activity' and you set the base name to be 'TEST' then the two files will be named 'TESTwaveform.JPG' and 'TESTactivity.JPG'.

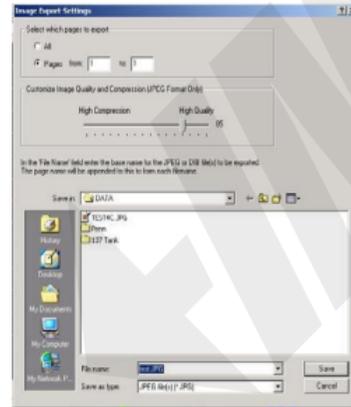


Figure 3.14: Export to JPG

3.3.1.13 Copy Screen to Clipboard

'Copy Screen to Clipboard' is used to save an image of the entire screen to the clipboard. This image can then be pasted in other applications such as word processors and image editors.

3.3.1.14 Exit

'Exit' is used to terminate the UTwin program. If you have made any unsaved changes to your current project, UTwin will prompt you to save your project first, or exit without saving or cancel.

3.3.2 View Menu

With this menu you can select which toolbars and information bars you would like to display on the screen. There are fixed positions for each of these toolbars defined on the UTwin screen, but some (Toolbar, Motion Controls) can be moved according to the user's preference by grabbing (left clicking the mouse) the handle (vertical bar) at the left side of the toolbar and moving it to the desired location. The settings on this menu are saved internally (i.e.: not in the project file).

3.3.2.1 Motion Jog Dialog Bar

Click the 'Motion Control' menu item to toggle the Motion Control Bar to be visible or invisible. The Jog Dialog Bar allows you to move the UT system manually under user and computer control.

Clicking on an arrow button jogs or moves the motor in the appropriate axis and direction. Clicking and holding on an arrow button will jog the motor a greater number of steps. Holding the SHIFT or CTRL key and clicking on an arrow will jog the motor by a step specified in the Motion Control settings dialog.

The scanner can be set to a specific position by entering the position value in the 'Set Position' edit box for each axis and clicking on 'Set Position'. It should be pointed out that the motor position is always relative to the origin (0, 0, 0 ...) of the scanner. The origin of the scanner is where it is located when UTwin is started. Of course, the origin can be changed by jogging the motor to any desired position and setting that position as the Home using the 'As Home' button.

Clicking 'Goto Position' to move to the position specified in the edit boxes. Clicking 'Goto Start' will move to the C-Scan start position. Clicking 'Go Home' will move to the home position. Clicking on 'STOP' will stop the motor. Clicking 'As Start' to setup the C-scan start position. Clicking 'As End' to setup the C-scan end position.

Clicking the 'Settings' will bring up the Motion Control Settings dialog as shown in Figure 3.16. In this dialog, you can change speed, acceleration and motion direction and the number of motion steps when CTRL or SHIFT key is pressed. In the speed control panel, you can change the speed factor from 0 to 2. The actual motion speed for all axes will be multiplied by this speed factor.

Note: when the motion control bar is activated, you can use left/right arrow keys to move X axis, up/down arrow keys to move Y-axis, Q/W to move Z-axis, E/R to move T-axis, T/Y to move G-axis and U/I to move S-axis.

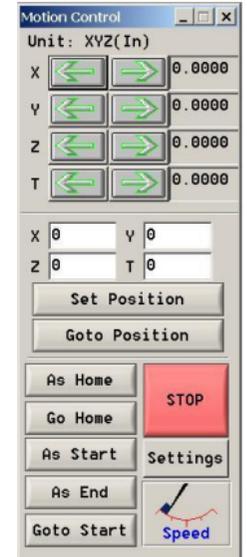


Figure 3.15: Motion Control

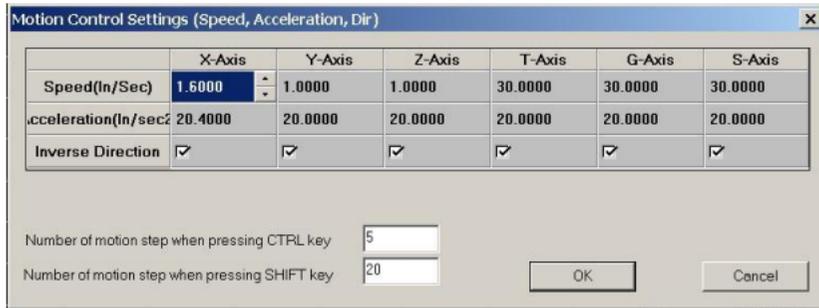


Figure 3.16: Motion Control Settings.

3.3.2.2 Alarm Dialog Bar

Clicking the 'Show Alarm Bar' menu item to toggle the Alarm Indicator Bar visible or invisible. The Alarm Indicator Bar shows alarm status. When an alarm is triggered, its color will change from dark to red.



Figure 3.17: Alarm Dialog Bar.

3.3.2.3 System Color Settings

Selecting this menu item to open the Color Settings Dialog as shown in Figure 3.18. In this dialog, you can change color of the cursors and the background color for all text annotations. If the 'Transparent' box is checked, text annotations will have no background color. Color for no gate synchronization and no gate data are used in C-scan image graphs to plot these acquisition points which have no valid gate value.

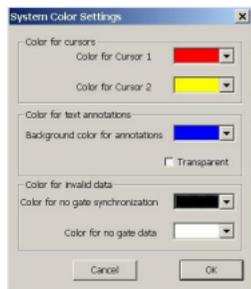


Figure 3.18: System Color Settings Dialog

3.3.3 Configuration Menu

The primary function of this menu is to configure the UTwin™ hardware (motor and data acquisition boards) for an ultrasonic test. The setups of a given set of hardware are unique and need not be changed after the initial setup. However, addition or deletion of hardware components can be accomplished via the configuration menu.

3.3.3.1 General Setup

Selecting this menu item to open the General Settings dialogs shown in Figure 3.19.

In the 'Inspection Customization' section, click the 'Setup Inspection Procedure' to open the 'Inspection Procedure' dialog shown in Figure 3.20. In the 'During inspection' box, you can activate following operations during testing:

- 1) Require input sample ID before each inspection. If activated, a dialog for inputting inspection parameters will be shown before each testing.
- 2) Automatically generate file name using sample ID. If activated, a file name based on the sample information will be generated after each test.
- 3) Automatically save data after each test. If activated, data will be automatically saved based on the automatically generated file name.
- 4) Automatically go home after each test. If activated, the scanner will move to pre-defined home position after each testing. This position can be used as a safe position for inspectors to load and unload testing samples.
- 5) Automatically run flaw analysis after each test. If activated, flaw analysis will be performed after each test and immediately give testing pass (no flaw found) or fail (flaw found) result.
- 6) Automatically generate data log after each test. If activated, project information and testing results are saved in a text file after a test. The log files are saved in the same folder where has the UTwin.exe program. Users can use the 'Inspection Log' to view the log file.
- 7) Automatically print data log after each test. If activated, the project information and testing results will be print out immediately after each test.
- 8) Automatically restart next test.
- 9) Require calibration for every **** min. For some inspection jobs, calibration is mandatory after several hour testing. Users can specify the required calibration period and the program will automatically suspend testing and load calibration project when calibration is required.

In the 'During Starting Program' box, you can activate following operations:

- 1) Ask user ID and password when starting UTwin. If activated, a small dialog for verifying password will appear.



Figure 3.19: General Settings

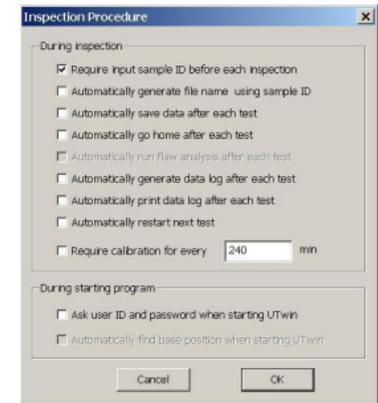


Figure 3.20: Inspection Procedure.

- 2) Automatically find base position when starting UTwin. If activated, the scanner will automatically move to the base position.

Using the 'Project Data File Folder' list box to select the default folders for storage of Data and Layout files. These are the folders that are displayed by default in the various Open/Save Project and Save/Replay dialog boxes. The 'Project Setting File Folder' is also where UTwin looks for the autoload 'UTwin.pro' file on startup. By default these are both set to the folder found in the installation folder of UTwin.

In this section 'Unit and Language' section in the general settings dialog, you may choose between English (in) and Metric (mm) measurement units for all the tests. You may select the language for the user interface. You may need to properly configure your operating system on the computer where this program has been installed. East Asia languages (Chinese, Japanese) will require a special Windows operating system.

3.3.3.2 Hardware Setup

Selecting the 'Hardware' menu item under the configuration menu, the Hardware Setup dialog will be displayed (see Figure 3.21). This dialog includes three pages and allows you to directly set up the scanner, the Pulser/Receiver and the Digitizer.

3.3.3.2.1 Scanner Setup

This section allows you to setup parameters and axes information of the scanner in use. These setup parameters are usually fixed for a given bridge or scanner. Up to eight axes (X, Y, Z and turntable T, Gimbal axis G and Swivel

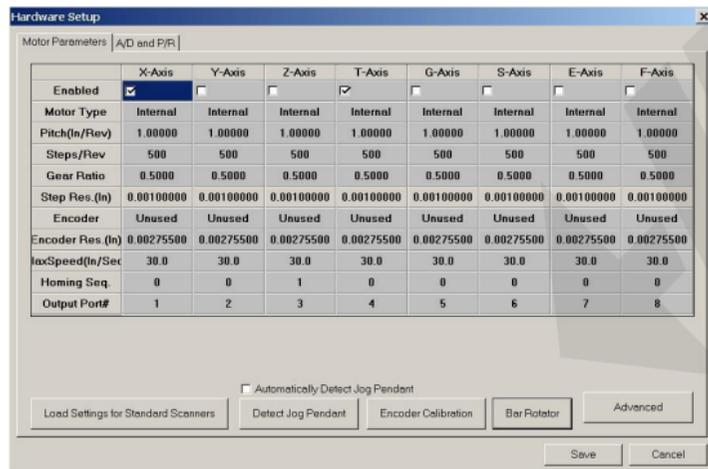


Figure 3.21: Hardware Configuration Dialog.

axis S, E and F) can be configured. (Please see Eight Axis Option for the G, S, E and F). The following information is required to complete the configuration.

Enabled: Click the check box so that a check appears if the motion axis is used on the system for motion control.
Motor Type: Every scanner used for data acquisition falls into one of the following broadly defined categories. You can choose Internal by clicking the up and/or down arrows on the right side of the list box. The description of these categories is as follows:

- Internal: Choose this option if the scanner is powered by stepper motors, under ULTRAPAC control.
- Encoder Only: Choose this option if positions are determined by external encoder feedback. This option usually is selected for manual scanning.

Pitch(In/Rev): The pitch is defined as the linear distance advanced per turn of the lead screw.

Step/Turn: This refers to the number of pulses (steps) sent by the stepper motor controller card to the motor for one complete revolution of the motor.

Gear Ratio: This refers to the number of revolutions of the lead screw per motor revolution. For example, a gear ratio of 1.5 means that the lead screw will make 1.5 revolutions (1.5 x 360 = 540 degrees) while the motor makes one revolution (360 degrees).

Step Res.: The step resolution is defined as the minimum distance that can be advanced for one pulse of the motor. This is computed based on the input parameters lead screw pitch/belt translation, (designated as pitch in menu) step/turn, encoder ratio and gear ratio.

Encoder: There are three selections for this item: Unused, Quadrature, Dir/Step. If there is no encoder, select Unused. If the encoder signal is a quadrature signal, select the "Quadrature" mode. If the signal is Step/direction, please select the "Step/Dir" mode.

Encoder Res.: This refers to the encoder step resolution.

MaxSpeed(In/Sec): This is a software limit. This limit will safeguard the operation of the stepper motor. When the Jog or scan speed is bigger than the value specified here, the software will generate a warning to the user and reset the speed to the maximum speed.

Homing Seq.: Define the motion sequence for each axis when moving to home position. The axis with smaller number moves first.

Output Port#: There are four output ports for SMC4 and eight output ports for SMC8. You can map each axis to any output ports.

Load Settings for Standard Scanners: You can load motor parameters for standard scanners made by NDT Automation such as LSI, Z-Scan systems.

Detect Jog Pendant: Click this button to detect and initialize the jog pendant. If the **Automatically Detect Jog Pendant** is checked, the jog pendant will be automatically detected and initialized when starting the program.

Encoder Calibration: Click this button to start Encoder Calibration Dialog as shown in Figure 3.22. (This is a password-protected feature. Only authorized users are allowed to perform encoder calibration because it could change your system settings).

To perform calibration, follow the four steps illustrated in the dialog. First select the axis for calibration, then input the distance you have decided to move. Usually longer distance results more precise calibration. Next click 'Start Calibration' button, then you can start to move your encoder the pre-defined distance. You can move your encoder manually or using the '<' and '>' arrow buttons. When you are moving the motor, you will see the number of encoder count displayed in the edit box is changing. Once you have reached the pre-defined distance, click 'Finish Calibration for This Axis' button. You will see the calibrated encoder resolution and encoder ratio are displayed in the corresponding edit boxes. Once you click OK, the encoder resolution of your system will be revised based on the calibrated value.

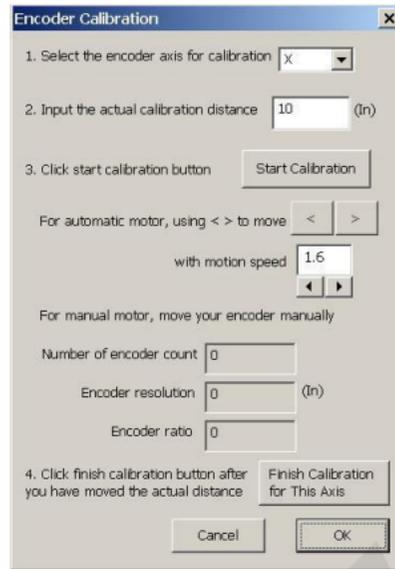


Figure 3.22: Encoder Resolution Calibration Dialog.

Clicking the **Advance** button will initiate the advanced setting dialog box shown as below.

Accel/Decel Type: There are two acceleration/deceleration types. Linear acceleration/deceleration and S-curve acceleration/deceleration. The linear mode uses a constant acceleration/deceleration and the S-Curve uses a varying acceleration/deceleration so that the maximum speed can be achieved with a smoother transition.

Jog Stop Mode: When jogging the motor, the motor can be stopped immediately if "Immediate" mode is selected or the motor will be stopped with a deceleration period if "decel" mode is selected.

Step CLK PW: This is the step clock pulse width in micro-seconds. The SMC-PCI board uses an internal clock of 40KHz. Depending on the operation speed, this value should be set accordingly. The rule of thumb for the pulse width selection is: pulse width <= 100,000 stepRes/(2*speed). For example, if the stepper motor has a step resolution of 0.002 inch and the operation speed is 20inch/s. The pulse width should be less than 100,000*0.002/(2*20)= 5micro-seconds.

Limit Switch Type: There are 4 modes of Limit Switch Type. They are unused, Max, Emergency and Combined.

Start Speed (%): In order to achieve a smooth transition at the beginning of the motion, a proper starting speed needs to be specified. The starting speed is specified as the percentage of the operation speed. In jogging mode, the starting speed is the percentage of the jogging speed. In scan mode, the starting speed is the percentage of the scanning speed. The default value is 1%.

Base Switch: Absolute home position switches. There are three selections for this item: Unused, Positive, Negative. If there is no base switch, select Unused. If Positive is selected, then when you select the "Goto Base" in the main menu, the motor will go positive direct to find the base switch; if negative is selected, the motor will go negative direct to find the base switch.

Base Position: Absolute home position.

Index Pulse: If this check box is checked, the position counter will be reset upon completion of every motor revolution on the selected axis.

Ext. index Pulse: Check this box if an external motor is used and the source of synchronization is an index pulse into the Stepper motor board.

Safety Check: not implemented.

+Limit Polarity: Depending on the hardware connection and limit switch polarity, limits can be active low or high. Each limit can have an independent polarity. This setting does not matter if the limit switches mode is "not used"

-Limit Polarity: See above

Direction CTL Polarity (High): If this is checked, the direction control polarity is set as active high, otherwise it is active low.

Step CLK Polarity (High): The step clock polarity set the active level of the step output. If it is checked, it will set the step output as active high

Internal Power Shutdown: When this power supply is shutdown, only the digital inputs/outputs are operational.

Motion Control Board: The following motion control boards are supported by the UTwin software:

- PAC_SMC48: NDT Automation's programmable motion controller.
- PAC_DEMO: Simulated motion controller for demo only.



Figure 3.23: Advanced Settings for SMC-PCI Board.

PROM Version: This output information tells what the PROM version of the using SMC-PCI board is.

3.3.3.2.2 AD/PR Board Setup

Select A/D and P/R tab to bring up a page which allows you to configure active channels, the Pulser/Receiver and the Digitizer.

Channel: For standard UTwin, up to 8 channels are supported. Toggling the checkbox to activate or deactivate a channel. The channel number presents the logic index which has to be a continuous number.

Pulser/Receiver: This section allows you to select a Pulser/Receiver for the test. The appropriate Pulser can be chosen by clicking on the desired option. The following Pulsers are supported by the UTwin software:

- AD_IPR-1210: NDT Automation’s programmable pulser/receiver board with 100Mhz bandwidth
- IPR-100: NDT Automation’s programmable pulser/receiver board with 100Mhz bandwidth (Windows 98 ONLY; do **not** use in Windows 2000 or XP).
- PR-60 (or JSR-300): JSR-300 pulser/receiver is used for high frequency transducers (> 20MHz).
- MUX1615: NDT Automation’s 8 channel multiplex.
- External: This refers to a pulser or flaw detector which can be triggered externally. The RF output from an external pulser is fed into digitizers.
- PR_DEMO: Simulated P/R for demo only.

Digitizer: This section allows you to select a digitizer board which you will be using for the test. The appropriate digitizer can be chosen by clicking on the desired option. The following digitizers are supported by the UTwin

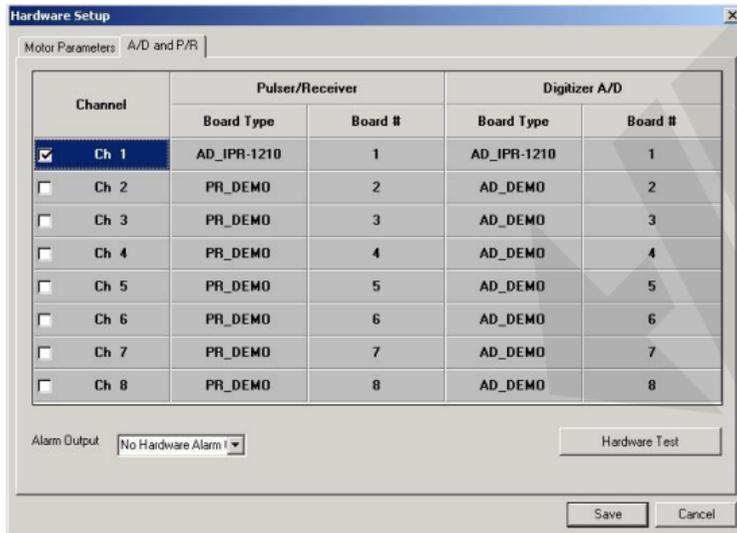


Figure 3.24: Board Configuration.

software:

- AD-1210: NDT Automation’s programmable digitizer card with 100MHz base sampling rate
- AD-IPR-1210: NDT Automation’s programmable AD-1210 card with a programmable Pulser/Receiver module attached with it.
- AD-8xG: NDT Automation’s 8bit digitizer board with 1.5, 2, 3, and 6GHz sampling rate.
- AD-81G: NDT Automation’s 8bit digitizer board with 1GHz sampling rate.
- PCI8: Physical Acoustic Corporation’s PCI8 card.
- AD_DEMO: Simulated A/D board for demo only.

Board #: This is the physical board number which is usually controlled by switching pins on the boards. You can map any logical channel to any physical board. For example you can enable four logical channels and map them all to one A/D board. However channels sharing the same board will have the same hardware settings.

Alarm Output: From the drop list to select the IO board for alarm status output.

AD/PR Calibration: This function is for internal or advanced users only.

3.3.3.2.3 Other Boards

UTwin also supports other boards, which are used to record non-ultrasonic data.

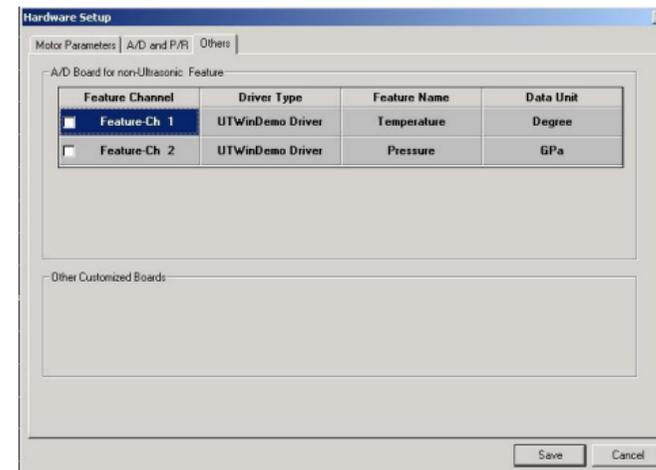


Figure 3.25: Non-Ultrasonic boards.

3.3.3.3 Inspection Mode

UTwin is a platform for many inspection methods: ULTRAPAC, LSI, TubeScan, TOFD, Welding Inspection, Contour Following, et. Click the menu item to change your inspection mode. The user interface will automatically change based on the selected inspection mode. Regarding each inspection mode, please see Section 9 for turnkey systems.

3.3.3.4 Color Palette

Select the Color Palette menu item to bring up the Palette Edit dialog as shown in Figure 3.26.

In the 'Palette List' group, all your saved palettes are listed in the dropdown list box. You can recall a palette from the list box. Click the 'Add to List' to add current palette into the list box. Click the 'Remove from List' to remove the current palette from the list.

In this dialog, there are several controls used to modify the color distribution in the palette.

Edit Color Num.: number of free points which you can move in the color-editing graph. The free-editing points are displayed as a small rectangle (red, green and blue) in the color-editing graph. Dragging these free-editing points to change the color intensity (horizontal position). The color distribution in the palette bar is calculated by interpolating the colors at these free-editing points.

Num. of Color: number of color in the palettes. The valid number is between 2 and 254. 255 and 256 color indices are reserved for internal use only. When the number of level is less than 64, a vertical black scale bar will appear at the left side of the color-editing graph. You can change the size of each threshold level by dragging the level indicators (these short horizontal lines in Figure 3.26).

Besides modifying the color palette by dragging the editing points in the graph, you can specify the threshold and color directly using the corresponding edit box. This direct edit method is useful when the number of color is small. You can use the embedded palette method to create a more complicated palette. As shown in Figure 3.27, a 16 gray color palette is embedded in the second color box in the editing palette.

Since it is a bit of a chore to set color palettes and since the user may have a preference for multiple color palettes and colors, UTwin software allows you to save and recall color palettes at will. Once you finish setting a color palette you can save the color palettes by clicking the 'Save' button. All color palettes in the list are saved in a file called UTWinPal.lib in the folder where you installed your UTwin. These saved palettes will automatically be loaded when opening the palette dialog.

Check the 'Apply to All Images' box if you want the palette to be applied to all graphs that have a palette. If not checked, the palette will be applied to the current active graph.

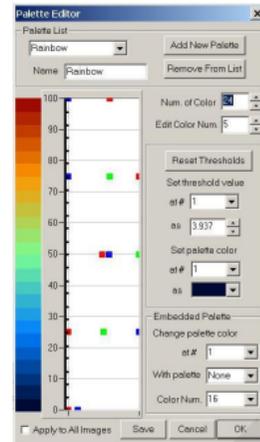


Figure 3.26: Color Palette Edit

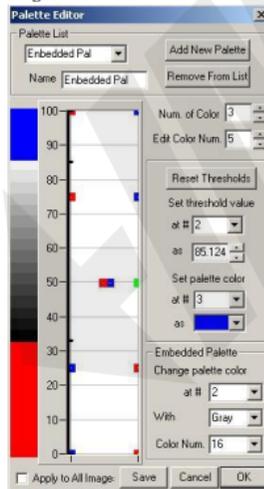


Figure 3.27: Embedded Palette.

Except color distribution, each palette also has its only scales displayed at the left side of the color bar. You can edit the scale by double clicking the scale or opening it from the graph setup dialogs. Figure 3.28 shows the Palette Scale Dialog. The unit selection is dependent on the type of data displayed in the graph. Checking the 'Auto Scale' box allows the program to automatically determine the Start and End Value based on the system settings. You can enable the Start and End Value edit box and manually input your value if the 'Auto Scale' checkbox is not checked. This scaling change affects the image coloring.

3.3.4 A/B-Scan Menu

Selecting 'Start' submenu item allows you switching to A-Scan (and B-Scan) mode. See section 4 for operation of this mode.

3.3.5 C-Scan Menu

Selecting the 'Start' submenu item allows you to switch to C-Scan mode. See section 5 for operation of this mode.

3.3.6 Replay Menu

Selecting 'Start' submenu item allows you switching to Replay mode. See section 6 for operation of this mode.

3.3.7 Graphing Menu

See section 3.4 for graphing in UTwin.

3.3.8 Analysis Menu

UTwin includes many advanced analysis tools such as statistics and cluster analysis and automatic reporting tools such as exporting data and graphs to Microsoft Excel and Word. See section 6 in replay mode for details

3.3.9 Page Menu

With this menu you can create insert, delete and rename screen pages. This is a UTwin screen page management menu. You can also perform these functions with the icon keys and a right mouse click on the screen page tab. See more details in Section 3.4.

3.3.10 Window Menu

This is a typical 'Windows' menu that you would find on any common WINDOWS program and therefore the menu contents should be familiar. It allows you to arrange your graphs in cascade or tile patterns as well as edit their window settings. Select 'Maximize Graph' to enlarge the active graph, and 'Restore Graph' to return it to its normal size.

- Move Graph or Table: Use this command to move a graph or table using the mouse.
- Close Graph or Table: Use this command to close the selected graph or table.
- Cut Graph or Table: Use this command to cut a graph or table, presumably for later pasting on another page.
- Copy Graph or Table: Use this command to copy a graph or table, presumably for later pasting on the same or other page.
- Paste Graph or Table: Use this command to paste a cut or copied graph or table onto the current page.

See more details in Section 3.4.

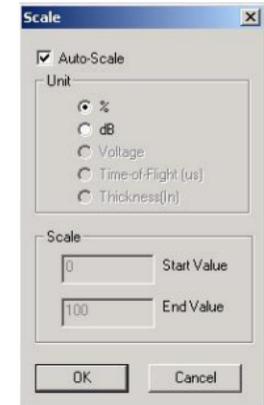


Figure 3.28: Palette Scale Dialog.

3.3.11 Help Menu

With this menu you can get some on-line help to the operation of certain features of the software. You need to install adobe reader (PDF file) to open the help file. In addition, the “Options” selection informs the user which options have been installed in his/her UTwin software and the “About UTwin” informs the user to the release version and date of UTwin.

3.4 Graphing in UTwin

The graphing capability in UTwin is very impressive, as it should be since data visualization is very important in UT testing. UTwin is able to provide multiple graphs, multiple plots within a graph, multiple graphs on a screen (or “Page” using Windows terminology), and multiple screens (Pages) full of graphs. The graph types can multi-dimensional (2D and 3D) graphs, color images. Graph axes can be set up to be fixed scaling (always stays at a fixed minimum and maximum value), automatic scaling (compression or sliding scale) logarithmic or linear scaling.

Before getting into the setting up of Graphs in UTwin, it is important to define the terminology used in graphing on UTwin. This will be used throughout the manual.

Plot: A plot is defined as a single curve within a graph (or graph window). Since a graph can be set up with multiple plots inside, we need to distinguish the difference between the word graph as a graph window and the fact that there can be multiple plots in a single graph window. We therefore call this a plot. So now we can say there are multiple plots within a graph or graph window.

Graph: A graph is a single Window on a Screen or Page. A graph is controlled by its property menu. The graph can have multiple plots of the same type within it.

Screen or Page: A screen or Page is the graph(s) that show up in the display area of the UTwin screen. This the area between the top and bottom tool bars (see Figure 3.1). A screen or page has a page tab located at the bottom of the screen to select between the screen pages.

There is no limit to the number of graphs that can be placed on a screen, the only limitation is a physical one, pertaining to the readability of the graphs.

3.4.1 Graph Setup Procedure

The following is the step-by-step process in setting up graphs in UTwin. This assumes that you are starting from a very simple single screen, single graph arrangement, into a multiple graph, multiple screen setup.

1. Before starting, give a little thought to the number of screen pages your application will need, what the theme will be for each screen page (for tab labeling considerations) and how many and what type of graphs you would like on each screen. The better you plan this out, the easier and faster the graphing setup process will be.
2. Find an existing Project file that gets you partially to your goal. You can then edit that layout file to meet your exact needs. You also can utilize these saved standard user interface (see Section 3.3.1.6). It is always easier to start with an existing layout. You can easily copy and paste graphs that have already been setup, saving a lot of time. If this is not possible, select **File New Project** which will start with 1 screen page (labeled A-Scan) and one A-Scan graph.
3. Create the number of screen pages that you need by adding and deleting screen pages, then edit the Page tab titles to the desired name or description of what that page will contain.
4. Create the number of graphs you need in each screen page by adding or deleting graphs.
5. Size your graphs as desired and tile them as desired so that they are laid out in the order that you wish.
6. Individually setup each graph in each graph screen to get the desired result. Enter the graph setup menu for each graph by right clicking the mouse when it is inside the graph, then select the pop-up menu called ‘Graph Setup’ or double clicking the graph to enter the graph mode.

3.4.2 Screen Page and Tab Management

As with all Windows operations, there are various ways to add and edit Screen pages. The most convenient is by Right-clicking your mouse on an existing page Tab, adjacent to where you want to add the page. A Page/Graph setup menu will appear. To add a New Page after the selected page, simply select the **New Page** menu item. To insert a new page before the selected page, select the **Insert Page** menu item. In either case, a new page and page tab will appear. The page tab will be labeled as “Page X”.

There are other ways to add a page including selecting the **New Page Icon** from the icon toolbar (looks like a blank page), which will always place a new page at the end of the screen page tab list. You can also go to the main menu bar and select the **Page Menu** to make the **New Page** and **Insert Page** selections.

Once you have created a new page, it will be empty (no graphs). You will add the desired graphs and will label the page tab. You may add as many graphs as you wish to the screen page.

To label the page tab simply right-click on that tab and select the “Rename Page” menu item. This will allow you to enter a page name. There are no major restrictions to naming a page tab. However do not make the page tab title too long as it might take up too much space.

There is one other screen page editing function, which allows you to remove or delete a screen page. Simply right click on the screen page tab and select the **Delete page** function. The screen page and tab will immediately disappear. If you had graphs in the screen page that you deleted, they will be deleted as well.

3.4.3 Adding, Placing and Sizing Graphs on a Screen Page

Once you have a Screen Page set up, you need to begin adding and placing graphs on it. If you know how many graphs you want and what types they will be you can quickly add and edit the graphs. If all the graphs are to be the same style (e.g. waveform graphs, one for each channel), you should start by adding a graph, defining it and then copying it as many times as you need. Then you can size the graphs and create the layout (position of the graphs) as desired and then you can edit the graph setup to finalize the graph function. If each graph is to be different, you can either copy similar graphs and paste them into the new screen page or you can simply add as many graphs as you want on the screen and edit the graph setup for each graph added.

To add a graph to the graph screen, simply right-click you mouse anywhere in the screen page and select the new graph menu item. Alternatively you can left-click the new graph icon from the icon toolbar menu. Additionally you can add a new graph by selecting from the main menu. Whichever way you select a new graph, a single graph will appear. To add multiple graphs on the screen, simply perform this function multiple times.

Once you have selected the number of graphs you want on the screen, you need to tile them. Tiling allows you to place them next to each other so that each part of every graph can be seen. There are two tiling options. You can use **Tile Horizontal** or **Tile Vertical**. The most convenient way to perform this function is to select one of these functions from the icon tool bar. The **Tile Horizontal** icon is shown as two graphs stacked on top of one another while the **Tile Vertical** icon shows two graphs side by side. Alternatively you can select these from the **Window** main menu. **Tile Horizontal** will favor a length-wise positioning of the graphs and will usually make the graphs longer than taller. **Tile Vertical** will give preference to a vertical direction. Choose one of these to place the graphs in a nice ordered manner.

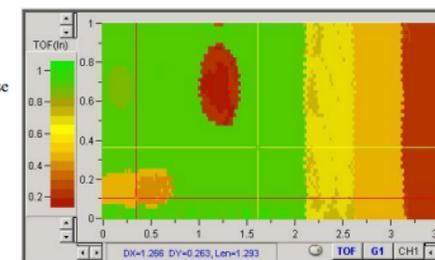


Figure 3.29: Cursors in Graph.

Once the graphs are placed on the screen, we can alter their sizes. We do this using the standard Windows conventions of moving the mouse to the edge of a graph until we see a double arrow and then left-click the mouse and move the edge in or out to make the graph larger or smaller. We can also move graphs by right-clicking on the graph and selecting the **Move Graph** menu item.

The final function that we need to perform is that of editing or setting up the graphs to perform the desired display function.

3.4.4 Maximizing a Graph to Full Screen

Sometimes you have many graphs on a screen and it is a little difficult to see the axis values clearly. You can expand any graph to full screen by right-clicking the mouse in the desired graph area, and selecting the menu item "Maximize Graph" from the graph menu. You can select the same function from the Main Menu bar, **Window Maximize Graph** selection. To restore the graph to its normal size and place on the screen, simply, right-click the mouse in the graph area and select "Restore" or **Window Restore Graph**.

3.5 Using Cursors

There are two cursor control icons (Single Cursor and Double Cursor) in the main toolbar as shown in Figure 3.2. The cursor readout controls are active in all graphs. Click the 'Single Cursor' toolbar button to show one cursor in the current active graph. The cursor is displayed as a red long cross (color is changeable). You can use the mouse to drag the cursor. The X, Y positions corresponding to the center cursor position are displayed at the bottom of the graph or next to the cursor. Depending on the type of graph, some other information corresponding to the center cursor position may also be displayed. Anyway, as you are moving the cursor around (with the left mouse button depressed), you can see the information changing as you move. This is a very handy feature to have. Click the 'Double Cursor' to activate two cursors on one graph; the first one is in red color and the second one in yellow color. In 'Double Cursor' mode, the difference (DX, DY) between the center positions of the two cursors is displayed, which can be used to measure the size and area of an interested region.

3.6 List of Shortcut Keys

The following is a list and short description of all the shortcut keys available in the software. Many of the shortcut keys follow in the tradition of PAC's software programs and should be familiar. Others follow standard WINDOWS conventions. Menu items usually do list the shortcut key, but the full list is provided below for convenience.

F1	Help Menu
F2	Hardware Setup
F3	Motion Jog
F4	
Ctrl + F4	Close (Delete) Graph
Shift + F4	Delete Page (Entire Graph Screen)
F5	Start C-Scan
F6	Stop C-Scan
F7	Pause C-Scan
F8	Resume C-Scan
F9	A-Scan mode
F10	C-Scan mode
F11	Replay mode
Ctrl + H	Window Tile Horizontal
Ctrl + O	Open Layout File
Ctrl + P	Print Page
Ctrl + S	Image processing

Ctrl + T	Window Tile Vertical
Ctrl + V	Paste Annotations
Ctrl + Z	Move to cursor position
Ctrl + Shift + C	Copy to Clipboard
Ctrl + Alt + O	Options Dialog

4. OPERATING UTwin – A- and B-SCAN MODE

You can click the **A-Scan** tool button or select **A-Scan->Start** to start or switch to A-Scan mode. The A-Scan toolbar (Figure 4.1) will be shown under the main toolbar. In A-Scan mode, you can configure the pulser/receiver, digitizer, etc. for a particular test. You can also perform a B-Scan (Feature Monitoring) in A-Scan Mode.



Figure 4.1: A-Scan Toolbar.

4.1 A/D Settings

Clicking the **A/D Settings** tool button or selecting **A/D Settings** submenu brings up a dialog box which provides you complete control over how the waveform is digitized. The dialog box is shown in Figure 4.2. Menu items are described below.

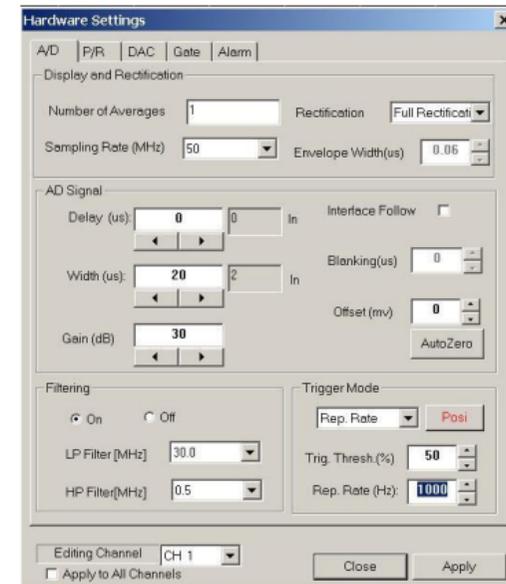


Figure 4.2: A/D Settings

Number of Averages: Multiple waveforms can be averaged to reduce the noise of the signal. You can enter the number of acquisitions for average. The greater the number of waveforms being averaged, the slower the effective update rate of the measurements and graph.

Sampling Rate (MHz): The sampling rate can be selected from the list box. The sampling interval of an ultrasonic signal is determined by the sampling rate of the digitizer. The digitizer chosen in the hardware configuration menu determines the minimum and maximum sampling rates. For best results, the sampling rate should be set to at least 10 times the center frequency of the transducer being used.

Rectifications: There are five rectification methods. The vertical axis limits of the A-Scan graph will be automatically adjusted to suit the selected waveform rectification mode. The modes are as follows:

- **RF Waveform:** The waveform is displayed exactly as it is sampled by the digitizer, with both positive and negative peaks.
- **+ Rectification:** Only positive peaks are displayed; negative peaks are truncated to zero.
- **- Rectification:** Only negative peaks are displayed; positive peaks are set to zero.
- **Full Rectification:** All peaks are shown, but as positive values. The sign of all negative waveform samples is changed to positive and the resulting waveform is displayed.
- **Envelope:** The envelope of the waveform is displayed. In this rectification mode, the **Envelope Width** edit box will be enabled and you can change its value.

Note: Measurements during the two gate periods are affected by the choice of rectification mode.

Delay: This is the post-trigger sampling delay. This controls the point at which the waveform starts recording. Clicking on the arrow keys on the left side of the edit box allows you to increase/decrease the delay value one step at a time. Clicking and dragging the box inside the horizontal scroll bar allows you to increase/decrease the delay several steps at a time. In addition, you can direct input the delay value to the edit box. The available maximum delay depends on the A/D board used.

Width: This is the length of time over which the signal is sampled and the waveform displayed and stored. This value may be increased or decreased in the same manner as the delay. The A-Scan waveform display uses this value and the Delay value above to set the X-axis limits. For best throughput and resolution, the Width should be set as small as possible. Because of the interaction of the sampling rate and memory size, the digitizer may not be able to cover the entire width range. This condition is indicated by a flat horizontal line in the A-Scan display for the affected part of the waveform. The maximum width depends on the A/D board used.

Gain(dB): This is the signal path (or A/D) gain. The current value is displayed and can be modified by entering a new value directly into the display box. Alternatively, click on the arrow keys to change the current value.

Interface Follow: For the AD-IPR-1210 board, checking this box can let the user select the interface follower option. If activated, the A/D delay will be the first reflection (usually interface reflection) after the **Blanking** period.

Offset (mV): allows you to digitally add an offset voltage to the waveform. Click the **AutoZero** button to automatically adjust the zero offset.

LP Filter: Low-pass filter. The low pass filter sets the maximum signal frequency which can be detected by the system. Use the drop-down list to select the desired value. The cutoff frequencies are dependent on the A/D board used.

HP Filter: High-pass filter. The high pass filter sets the minimum signal frequency which can be detected by the system. Use the drop-down list to select the desired value. The cutoff frequencies are dependent on the A/D board used.

Trigger Mode: For most A/D boards (e. g. AD1210), there are five trigger modes: Software, External, Rep. Rate, Positional and Threshold.

- **Software:** Triggers are generated automatically by the program, at a rate which may vary somewhat depending on different parameter and option settings. This is the default trigger mode.
- **External:** The trigger is derived from a signal connected to the Trigger-In connector on the front of the A/D board. This mode can be used to synchronize the A/D to an external Pulser, for example.
- **Rep. Rate:** The Repetition Rate (Rep. Rate) is the frequency at which triggers are generated. The triggers are derived from a hardware timer and therefore the rate is independent of other system settings. The repetition rate is set in the Rep. Rate (Hz) box.
- **Positional:** The trigger is generated when the encoder signals that the scanner has moved a certain distance. This distance is set in the Resolution box of the B-Scan or C-Scan Settings dialog box.
- **Threshold:** The trigger is generated when the input signal rises above a specific value. This value is set in the **Trig. Thresh.(%)** box, and is in units of Percentage of Full Scale.

Some A/D boards (e. g. AD-90, AD1210) can be triggered to collect the data after a leading edge (**Posi**) or a trailing edge (**Nega**).

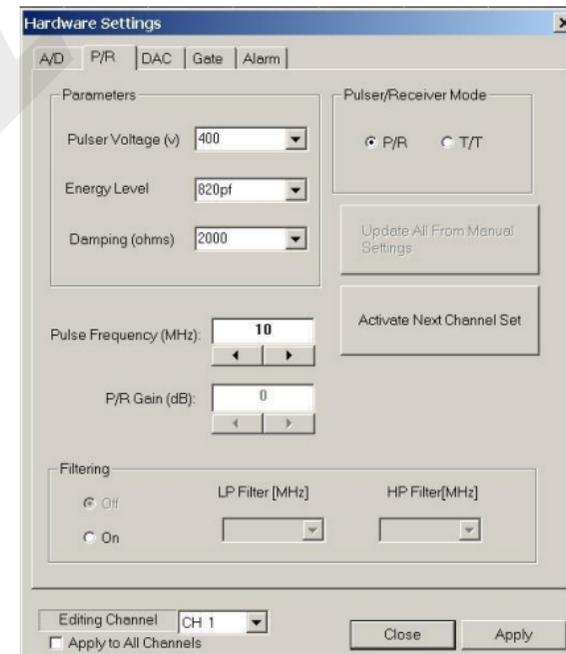


Figure 4.3: P/R Settings.

4.2 P/R Settings

Clicking the **P/R Settings** tool button or selecting **P/R Settings** submenu brings up a Pulsar/Receiver dialog box with detailed controls for setting up the Pulsar/Receiver for the test. The P/R dialog boxes is shown in Figure 4.3

Pulsar Voltage : Allows you to choose the high voltage of the output pulse from the drop-down list box.

Energy level : Allows you to choose the energy level of the output pulse from the drop-down list box.

Damping (ohms) : Allows you to choose the P/R damping from the drop-down list box.

Pulse Echo/Thru Trans: Selects the testing mode. Choose from Pulse Echo (Transmit/Receive) or Thru Transmission by clicking on the desired option.

Note: Choosing the appropriate inspection mode is crucial to successful UT testing.

Update All From Manual Settings: For an external pulser/receiver with remote control, you can click this button to update the value in the dialog box with the external manual settings.

Activate next Channel Set: This function is used for some special systems to switch among groups of transducers and multiplexers.

Frequency (MHz): This setting controls the width of the voltage pulse sent to the Pulsar transducer. Usually the value chosen corresponds to the center frequency of the transducers being used.

P/R Gain(dB): This is the gain of the P/R board. Clicking and dragging the box inside the scroll bar allows you to increase/decrease the gain value.

LP Filter: Low-pass filter. The low pass filter sets the maximum signal frequency which can be detected by the system. Use the drop-down list to select the desired value. The cutoff frequencies are dependent on the P/R board used

HP Filter: High-pass filter. The high pass filter sets the minimum signal frequency which can be detected by the system. Use the drop-down list to select the desired value. The cutoff frequencies are dependent on the P/R board used

4.3 DAC Settings

Selecting **DAC Settings** submenu brings up a DAC setting dialog box with detailed controls for the DAC, TCG and AGC setup. The DAC dialog is shown in Figure 4.4.

DAC is known as Distance Amplitude Correction, TCG is known as Time-Corrected Gain and AGC is known as Adaptive Gain Control. AGC looks for the peak signal value within the Gate 1 period, and then calculates the signal path gain necessary to bring that peak value to the desired percentage of full-scale screen. This signal path gain value is then applied to the signal during the entire waveform digitization.

DAC (TCG) allows different gain values to be applied to the signal path at different times during the digitization. Very often DAC may be used to compensate for attenuation in the material under test, since, as the signal propagates through the material, its amplitude decreases. The longer the digitization time, the more the signal has been attenuated. Using the DAC (TCG) feature, successively higher gains can be applied to the signal as digitization proceeds.

Backwall Attenuator (BWA) allows different attenuation/gain to be applied to the signal path within the backwall gate. Very often BWA may be used to attenuate a saturated backwall reflection. Thus the attenuated backwall will have amplitude less than 100% and can be monitored.

For DAC (TCG) Setup:

Desired TCG Level(%): The desired amplitude level for TCG can be changed by directly entering the value into the editor box.

Automatic Set TCG/DAC Gain: If checked, the program will automatically find the required TCG/DAC gain to bring the signal amplitude to the desired level.

First Echo – The TCG/DAC start position is synchronized with the detected First Echo. The synchronization threshold level is the same as that used for the gate.

Initial Pulse Trig– The TCG/DAC start position is synchronized with the initial pulse.

TCG/DAC Table: In this table, the first column (“#Num”) represents the index number (from 0-39). The second column is the TCG/DAC position in microseconds. In TCG/DAC setup mode, a blue cursor in the A-Scan graph indicates the current TCG/DAC position. The third column is the amplitude at the TCG/DAC position, the fourth column is the DAC amplitude and the fifth column is the TCG gain in dB at the corresponding position. To change the value for any cell in the table, simply click the cell and a data entry box (with up-down buttons) will appear as shown in the first cell in Figure 4.4. You can click the up and down arrows to change the value step by step or type the value directly to the cell. This TCG/DAC table control allows you to set a TCG/DAC Table point by point.

Delete All Points: Clicking this button to remove all points except the first two points from the DAC table.

Delete Selected Point: Clicking this button to remove the selected point in the DAC table.

Click on **Save DAC/TCG Table** to save the DAC/TCG table in a given file.
Click on **Load DAC/TCG Table** to load the DAC/TCG table from a given file.

Show DAC Curves: if activated, one curve which connects all the DAC points will be displayed in the A-Scan graph. Two additional curves which are shifted from the first curve by user-defined offset are also displayed. One example is shown in Figure 4.5.

Show TCG Curves: if activated, one curve which indicates the TCG gain variation along the waveform will be displayed in the A-Scan graph.

Activate TCG: Activate or deactivate the TCG. Figure 4.6 shows an example of A-scan graph with TCG activated. Comparing with Figure 4.5, you can see that the four peaks corresponding to the TCG points have been amplified to 80% of full screen height. The TCG range is indicated by a yellow line shown at the bottom of the graph.

Activate AGC: Activate or deactivate the AGC.

Activate Backwall Attenuator(BWA): Activate or deactivate the BWA.

Note: only one of the three functions (TCG, AGC, BWA) can be activated at the same time due to hardware limitations.

To setup additional parameters for DAC curve, AGC and BWA, click the ‘DAC Curve and AGC Options’ button to bring up the DAC/AGC/BWA settings dialog shown in Figure 4.7.

Desired AGC Level(%): This is the desired peak signal value when AGC is activated.

AGC Control Gate: Only Gate 1 is supported.

Desired Attenuation (dB): This is the desired attenuation/gain when BWA is activated. Positive value represents attenuation and negative value represents gain.

Backwall Gate: Define which gate is backwall gate. Only Gate 1 is supported.

DAC curve 1 offset(dB) and DAC curve 2 offset(dB): These are the offsets used to plot the DAC curves.

4.4 Gate Settings

Before you can make a good UT measurement, you must first identify the segment of the RF waveform that is of interest. This is done by setting up a Gate, which is simply a window of time and an associated threshold. Standard UTwin™ currently supports four independent data gates. Clicking the **Gate Settings** tool button or selecting **A-Scan->Gate Settings** submenu brings up a dialog box (Figure 4.8) which allow you to activate the gates and set various parameters relevant to the measurement.

Setup for Gate #: Select the gate number for editing from the drop list.

Display Label: If this box is checked, the gate name will be displayed in the A-Scan graph at the left-top of the gate.

Enabled: Check this box to enable (activate) the gate.

Display Color: The color used to display gate in the A-Scan graph.

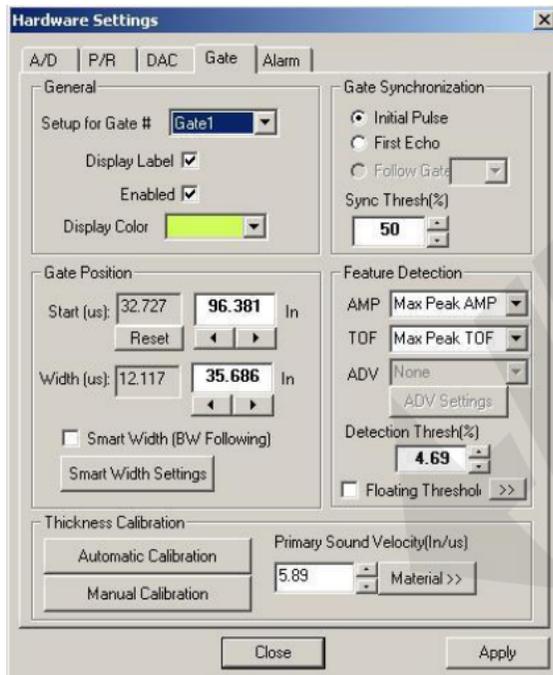


Figure 4.8: Gate Settings.

Gate Synchronization: There are three options for the synchronization signal. The first is **Initial Pulse**, in which the sync signal begins with the pulse sent to the Pulsing Transducer. The second option is **First Echo**, in which the sync signal from the left hand side of the RF waveform (A-Scan) display which exceeds the detection threshold level is considered to be the interface signal. The synchronization signal begins with this threshold crossing. The third is following another gate (not implemented).

Sync Thresh (%): The synchronization threshold for triggering the start of the gate from the first echo can be set to a level from 0 to 100%.

Gate Start (us): The gate start sets the gate delay from the sync signal. The value may be set either by directly entering the value into the box, or by adjusting the currently displayed value using the arrow buttons or scroll bar.

Gate Width (us): The width selection sets the range or width of the gate. The Gate width can be set in the same manner as the Gate Start value.

Smart Width: For a gate with smart width, the gate width will change with the position of the back-wall reflection. Click the **Smart Width Settings** button to setup additional parameters for a smart-width gate (Fig. 4.9). In the 'Smart Gate Width' dialog, you can specify the width control gate (backwall gate) and input the desired separation between the gate end and the backwall gate threshold crossing point. When the backwall threshold crossing point changes, the gate width will be automatically adjusted (shorten or lengthen) to maintain a constant separation between the end of the gate and backwall position.

AMP: The reported amplitude (AMP) for the gate can be either the highest peak value in the gate, or the height of the first peak. Use the drop-down list to select the desired measurement type.

TOF: The reported Time-of-Flight value (TOF) for the gate can be measured with respect to any of four measurements: time to First Peak, time to the first threshold crossing before the First Peak, time to Max Peak or time to first threshold crossing before the Max Peak.

Peak detection is useful when detection of the variation of peak amplitude of signals in the gated region is desired. Threshold Detection is used to detect the first waveform peak over the Detection Threshold in the gate region. Threshold detection is especially useful when signals with amplitude below a pre-specified value are not of interest according to a given standard or specification to perform an inspection. By setting up an appropriate threshold, the gated signals below the threshold level will be ignored for C-Scan processing and imaging. Each detection mode has its own advantages and disadvantages. The selection of the modes depends on the situation. If multiple gates are used for your C-Scan, you may set up different detection modes for different gates.

ADV: Beside conventional AMP and TOF UT features, UTwin also provides many advanced unique features such as phase angle, phase inversion, velocity, attenuation, et al. To use these advanced features, you need to have the Advanced Feature option enabled. Once this option is enabled, you can use ADV features the same way as you use conventional features AMP and TOF. See Section 7.6 regarding how to use advanced features.

Detection Thresh (%): The detection threshold can be set to a level from 0 to 100%. The threshold level is expressed in percentage of full screen. The threshold setting is used only when the First Echo mode is selected.



Figure 4.9: Smart Gate Width Settings.

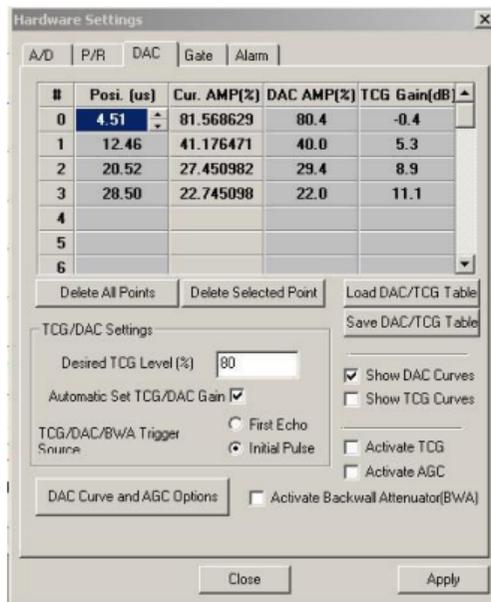


Figure 4.4: DAC Settings.

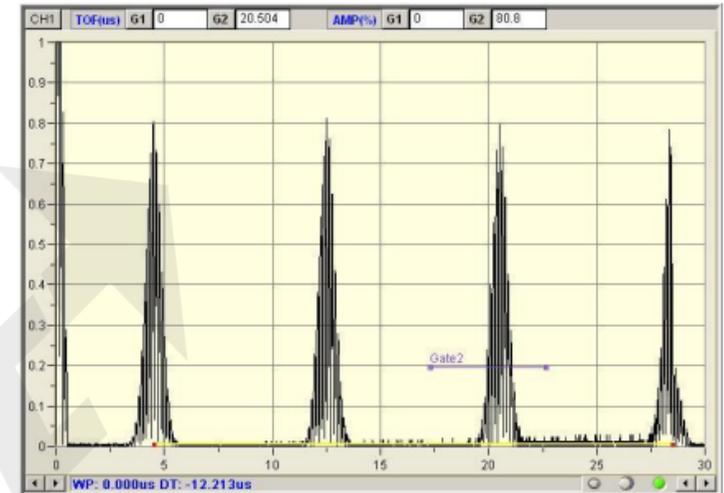


Figure 4.6: A-scan graph with activated TCG.

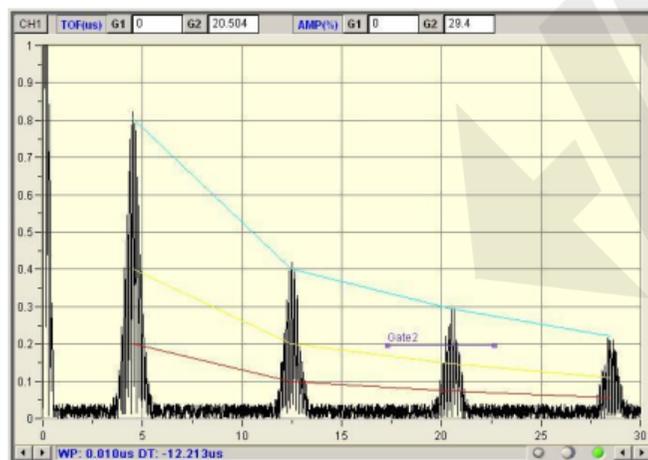


Figure 4.5: A-Scan graph with activated DAC curves.

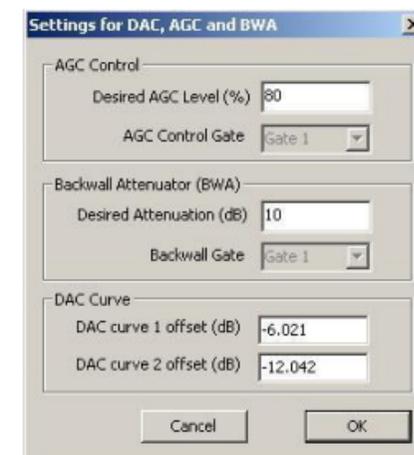


Figure 4.7: Settings for DAC, AGC and BWA.

Floating: The detection threshold can be set as a percentage of the gate amplitude value (instead of full scale) by checking the Floating checkbox. This means that as the gate amplitude is adjusted, the detection threshold will also change so that it remains at the same percentage of the gate amplitude.

Thickness Calibration: In UTwin, you can manually or automatically calibrate the equation for converting gate time-of-flight to gate thickness. The thickness is always calculated as: $\text{Thickness} = \text{TOF} * \text{Velocity} * \text{Factor} + \text{Offset}$.

Velocity: velocity of sound in the material under test.

Click **Automatic Calibration** to open the Automatic Calibration Dialog as shown on the top of Figure 4.6. Before calibration, you need to setup the gate properly.

Two reference samples (thick and thin) are required.

Step 1: Input the thickness measured by a micrometer for the two samples.

Step 2: Put your probe to the thick sample. Once the signal in the gate is stable, click "Record TOF" button to get the TOF value for this sample.

Step 3: Put your probe to the thin sample. Once the signal in the gate is stable, click "Record TOF" button to get the TOF value for this sample.

Step 4: Click "Do Calibration" to finish the calibration.

Step 5: Check your calibration results. Put the probe to both samples to verify the thickness displaying in the A-Scan window are correct.

You can check the "Apply Results to All Gates" to apply the results to all gates. You can also do calibration for each gate.

Click **Manual Calibration** to open the Manual Calibration Dialog as shown on the bottom of Figure 4.6. In this case, you simply change the velocity factor and zero offset manually until the thickness displayed in the A-Scan window are correct

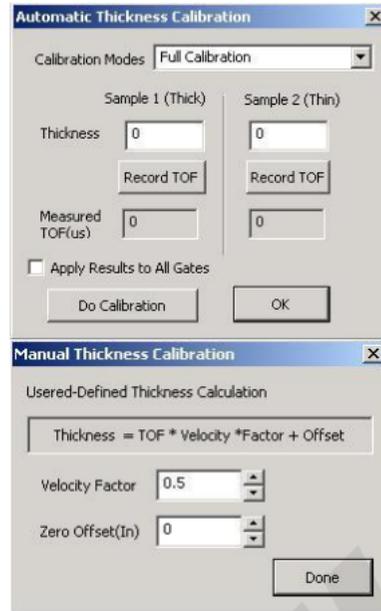


Figure 4.10: Automatic and Manual Thickness Calibrations.

You can use the User Settings for setting the Offset and velocity Factor for non-standard ultrasonic tests. For example:

- If you want the gate to monitor the water path, you can set the Offset value to (-1 x Nominal Water Path) and set the Gate to synchronize with the Initial Pulse and then detect the interface (or front wall). A positive thickness means that there is front wall corrosion by the amount reported (since the water path thickness is greater than expected). A negative thickness value indicates that the front wall is closer to the sensor.
- If you want to monitor the material loss, you can set the Offset value to be the nominal material thickness and set the Factor to -0.5 (for Pulse-Echo mode) or -1.0 (for Thru Transmission mode). In this case, the gate should be set up to synchronize with the first echo (interface or front wall) and detect the backwall echo. A positive thickness means that the net thickness is less than the nominal, indicating corrosion. A negative thickness means the material is thicker than nominal.

4.5 Alarm Settings

Standard UTwin currently supports 4 independent alarm outputs. Clicking the **A-Scan-> Alarm Settings** submenu brings up a dialog which allows you to activate the alarms and set various parameters relevant to the alarms.

Alarm List: Select an alarm for editing from the dropdown list.

Activate This Alarm: Check this box to enable (activate) the alarm.

The alarms are triggered based on the settings in Alarm Trigger Source and Conditions:

Alarm Channel: Channel index to acquire data for alarm condition evaluation.

Alarm Gate: Gate index to acquire data for alarm condition evaluation.

Alarm Feature: Data type for alarm condition evaluation

Average Number: Number of averages is used to calculate the data.

Min Amp(%) or Min THK(In): Low threshold value.

Max Amp(%) or Max THK(In): High threshold value.

Alarm Reset Time(sec.): This parameter is used to prevent rapidly trigger the alarm. If an alarm is triggered, it can be re-triggered only after the **Alarm Reset Time**.

Alarm Output:

I/O Output Port: Alarm status can be output to I/O port (I/O board has to be pre-selected in the AD/PR board settings, see Figure 3.24).

Alarm Log: Check this box to enable alarm information to be output into a file (Alarm Log). This alarm log is saved in your data folder automatically after each data acquisition.

Audio output: Check this box to enable audio output.

Stop data acquisition and scanning when triggered: If this box is checked and an alarm is triggered during B- or C-scan, data acquisition will be stopped.

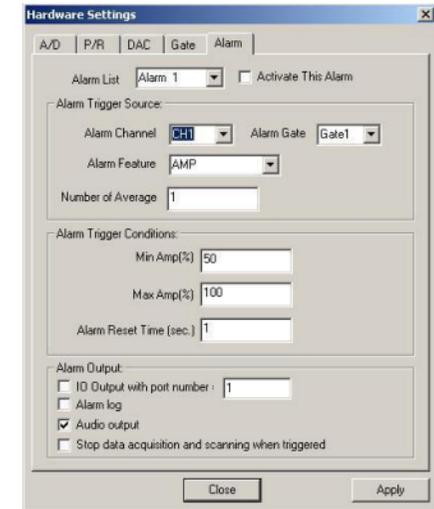


Figure 4.11: Alarm Settings.

4.6 Material Properties

Click the “Material Properties” menu item to bring up the Material Library dialog, which lists commonly used materials and their corresponding name, longitudinal, shear wave velocities and density. It also allows you to enter and display information on a variety of other materials. You can add/change or delete by using the modification buttons. The material under test is selected by clicking on that material name.

Click on the “Add New Material” button, or just enter a new name in the drop-down list to enter the characteristics of a new material.

The “Remove From List” button is used to remove from the list materials which are no longer of interest.

The list may be saved by clicking on the “OK” button. All materials in the list are saved in a file called UTWinMat.lib in the folder where you installed your UTwin. These saved materials will automatically be loaded when opening the Material Library dialog.

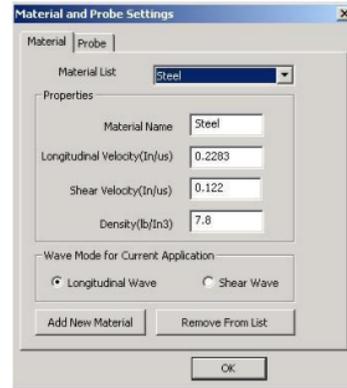


Figure 4.12: Material Library Editor

4.7 Probe Properties

Click Probe Properties menu item to bring up the Probe Editor dialog. In this dialog, you can input the probe angle, wedge(coupling) velocity, wedge delay, and center frequency. There is also a larger edit box at the bottom where you can input whatever information you want.

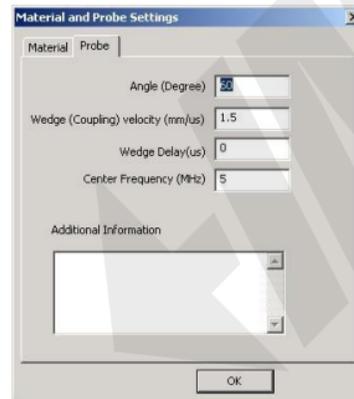


Figure 4.13: Transducer Editor Dialog..

4.8 Graph types in A-Scan

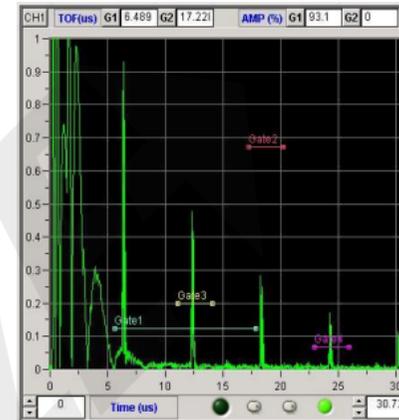


Figure 4.14: A-Scan Graph.

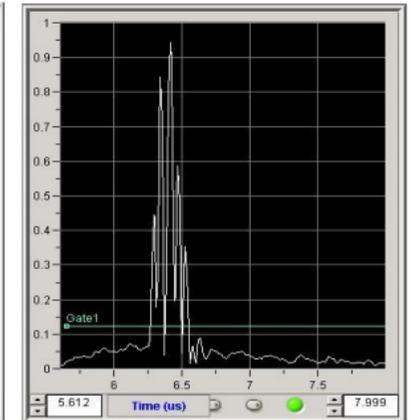


Figure 4.15: Zoomed A-Scan Graph.

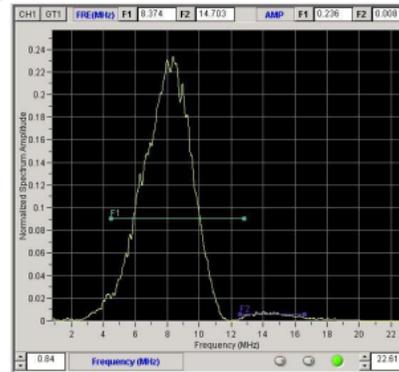


Figure 4.16: Spectrum Graph.

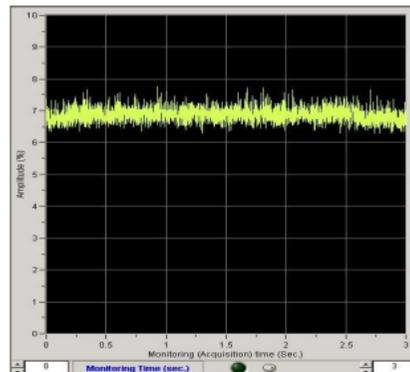


Figure 4.17: Feature Monitoring Graph.

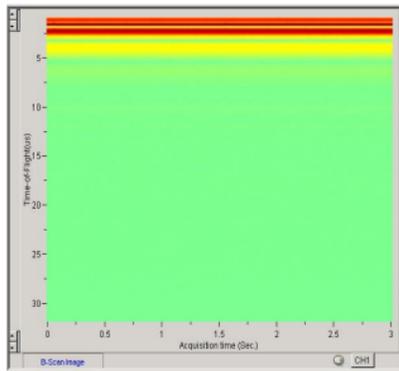


Figure 4.18: B-Scan Graph.

b-Scan Graph.

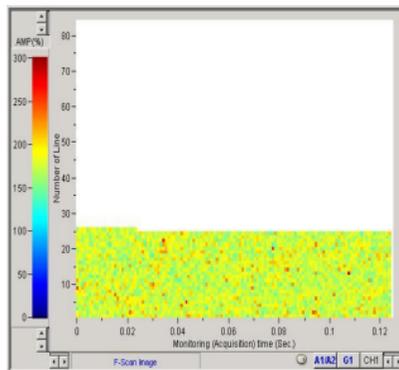


Figure 4.20: Feature Image Graph.

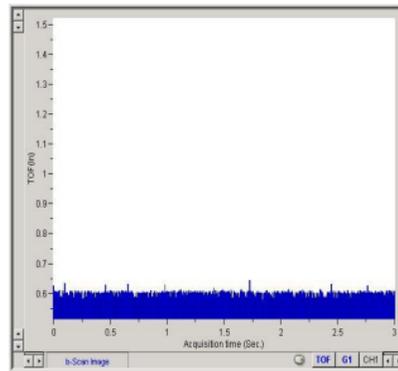


Figure 4.19:

In A-Scan mode, you can create:

A-Scan Graph(Figure 4.14): Waveform plot.

Zoomed A-Scan Graph (Figure 4.15): Waveform plot with arbitrary X-axis scale.

Spectrum Graph (Figure 4.16): Spectrum plot.

Feature Monitoring Graph(Figure 4.17): UT Feature (e.g. Ampl or TOF, etc.) versus time (or scanning axis) plot.

B-Scan Image Graph(Figure 4.18): B-Scan image.

b-Scan Graph(Figure 4.19): b-Scan Image.

Feature Image Graph(Figure 4.20): a pseudo 2D color presentation of the B-Scan (1-D) data.

4.8.1 Create Graphs in A-Scan

To add a graph to the graph screen, simply right-click you mouse anywhere in the screen page and select the corresponding menu item from **New Plot Graph** pop-up menu. Alternatively you can left-click the corresponding icon in the A-Scan toolbar menu. Additionally you can add a new graph by selecting the **Graphing New Plot Graph** main menu selection. Whichever way you select a new graph, a single graph will appear. To add multiple graphs on the screen, simply perform this function multiple times.

4.8.2 Graph Setup in A-Scan

This section discusses how to set up a graph. First, you select the graph that you want to modify. You do this by right clicking the mouse when it is inside the graph region of the graph that we want to work on. Once we do that a menu appears. This menu gives us many choices but we will select the one called "Graph Setup". Alternatively you can double-click the graph or click the 'Graph Setup' icon in the A-Scan toolbar menu. Upon selecting this a graph setup dialog appears.

4.8.2.1 A-Scan Graph Setup

Figure 4.21 shows the A-Scan Graph setup dialog. In the first 'Display' page, you select parameters for horizontal (H-Axis) and vertical (V-Axis) axes.

The display mode of the Horizontal axis scale can be set to either Distance or Time-of-Flight (TOF). To display the correct sound path, you need to perform calibration. Click the "Sound Path Calibration" button to open the "Sound Path Calibration" dialog box (See Figure 4.22). UTwin provides both manual and automatic calibration tools for calibrating the distance (sound path). Before doing calibration, you need to select **Distance** as the A-Scan x-axis display unit.

At the top of Figure 4.22, you see three editable parameters for sound path calculation:

Coupling Velocity: Sound velocity in the coupling material such as water.

Material Velocity: This is the primary sound velocity of the part under inspection. For multiple-layered parts with different velocity in each layer, select the velocity in the most importance layer as the material velocity.

Front Surface Detection Threshold(%): This threshold is used for detecting the threshold crossing position of the front surface reflection. The threshold crossing position is used to calculate water path length.

For manual calibration, you simply input the zero offset and velocity factor values. For simple cases, you can select the default calibration parameters from the **Use default** list box.

Steps for automatic sound path calibration:

STEP 1: Setup the pulser and receiver. Make sure there are two echoes with a known sound path showing in the A-Scan view. Moving gate one to the first echo and gate two to the second echo.

STEP 2: Input the sound path for the echoes in gate one (**Sound Path for Gate 1**) and gate two (**Sound Path for Gate 2**). Click **Calibrate**.

If there is only one echo with a known sound path, then move the gate one to that echo and input the sound path for gate one. Input a negative or zero sound path for gate two. In this case only the sound path offset will be calibrated.

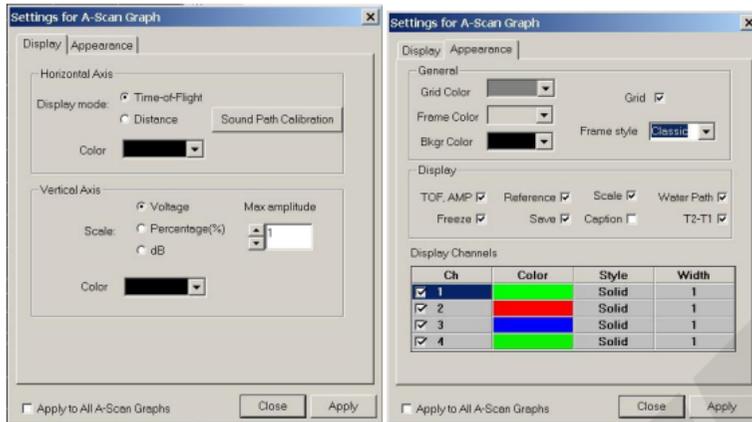


Figure 4.21: A-Scan Graph Setup.

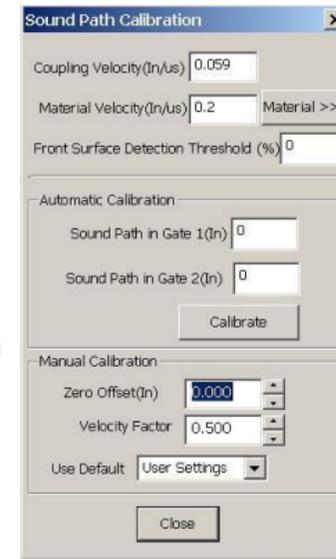


Figure 4.22: Parameters for Converting A-Scan Time-Of-Flight to Sound Traveling Distance.

The scale for vertical axis can be: Voltage, Percentage(%) or dB. If Percentage is selected, the scale of the vertical will be from 0 to 1 which presents 0% to 100%. If dB is selected, the dB value is calculated based on $AMP(dB) = 20\log(AMP\%/100)$, thus 0dB presents 100%. The maximum display scale is variable and you can change it by directly typing the value in the edit box.

Click the color box to change the display color for the axis label and caption.

In the 'Appearance' page, you can change the appearance of the graph. Change colors for grid, frame, Bkgr(Background) by clicking the color box; select the frame style(Classic or 3D) from the drop list; check the Grid box if you want the grid in the plot area to be visible. There is a group of check boxes, which are used to toggle the visibility of the controls around the graph:

- TOF, AMP** – Gate feature display at the top of the graph.
- Reference** – A small button at the bottom right of the graph which is used to toggle the reference waveform on or off.
- Scale** – Scale edit box for the H-axis.
- Freeze** – A small round button at the right bottom corner of the graph which is used to freeze the graph. Once a graph is frozen, its waveform will not be updated.
- Save** – A small button at the bottom of the graph. Click this button to save data or image of this graph.
- Caption** – show or hide caption for all axes.
- Water Path** – show water path at the bottom of the graph.
- T2-T1** – show T2-T1 at the bottom of the graph.

In the 'Display Channels' table, all activated channels are listed. The table has four columns (Ch, Color, Style, Width). Check the channels which you want to be displayed in the graph. Multiple channels can be displayed in one graph. Change the plot color, style and line width by clicking the corresponding column.

In the 'FFT' page, the parameters required for a FFT calculation are input. Click the dropdown box to select one preprocessing window. Applying a window to the gated time-domain signal can smooth the edge effect. You can change the power index n (2^n) to change the number of points in the FFT computation. A larger number results in better frequency resolution. For update priority, if the 'Realtime update' is selected, the spectrum plot will be updated after each waveform acquisition. If the 'Update once when power on' is selected, the spectrum will be updated after the power button at the right-bottom corner of the graph is turned from red to green.

The 'Spectrum Gates' page is used to setup the spectrum domain gates. Similar to the time-domain gates, you can setup two spectrum domain gates to detect spectrum-domain features (The minimum or maximum amplitude (FAMP1, FAMP2) and frequency (FRE1, FRE2) within the gate period. The minimum or maximum amplitude and frequency of the spectrum within the gates are displayed in the top of the graph.

Setup for Spectrum Gate #: Select the gate number for editing from the drop list.

Display Label: If this box is checked, the gate name will be displayed in the spectrum graph at the left-top of the gate.

Enabled: Check this box to enable (activate) the gate.

Display Color: The color used to display gate in the spectrum graph.

Gate Start (MHz): The gate start sets the spectrum gate delay. The value may be set either by directly entering the value into the box, or by adjusting the currently displayed value using the arrow buttons and scroll bar.

Gate Width (MHz): The width selection sets the range or width of the gate. The Gate width can be set in the same manner as the Gate Start value.

Minimum: The reported amplitude (FAMP) and frequency (FRE) for the gate is the minimum value and position within the gate.

Maximum: The reported amplitude (FAMP) and frequency (FRE) for the gate is the maximum value and position within the gate.

Detection Thresh (%): The Detection Threshold can be set to a level from 0 to 100%. The threshold level is expressed in percentage of full screen.

4.8.2.4 Feature Monitoring Graph Setup

The feature monitoring graph setup includes three pages as shown in Figure 4.25. This setup dialog includes three pages.

In the 'Feature' page, you select the data to be displayed on the graph. Using the 'Display Feature' drop-down list to select the feature name. Features included in a standard UTwin system are AMP, TOF, TOF2-TOF1, AMP1/AMP2. More features may be added in the future and in non-standard versions of UTwin. Up to four feature plots can be displayed in one graph. In the table, you select the data source for each plot. The valid channel number is from 1 to the highest enabled channel. The valid time-domain gate index is from 1 to 4. A plot will be disabled if its channel or time-domain gate is invalid. Change the plot color and style by clicking the corresponding column. In the 'Process' group, you can change the number of averages. This average is called 'running' average, i.e. the average window moving along the signal one acquisition data by one acquisition data based on a "first in first out" rule (FIFO). In real-time data acquisition, you can change the plot update rate by specifying how many acquisitions for one update.

In the 'Display' page, you change the color and scale for the H(X)- and V(Y)- axes. For H-Axis, if the 'Fit to View' is selected, the minimum and maximum values are determined by the monitoring start and end values. If the 'Scroll view(Only for real-time)' is selected, then each acquisition is displayed as one pixel and the scale of the H-axis is

calculated based on the graph width and scanning resolution. The plot will be scrolled to left once the maximum display value is reached. This mode is designed for real-time only. In replay mode, select this mode will make only the last portion of the data visible due to scrolling. For Y-Axis, if the 'Auto Scale' is checked, the program will automatically adjust the minimum and maximum value of the axis based on the plot data. If it is not checked, you can manually input the Start (minimum) and End (maximum) values using the edit box. The scale for Y-Axis can be linear or log. The color of the axis label and caption can be revised using the color edit box.

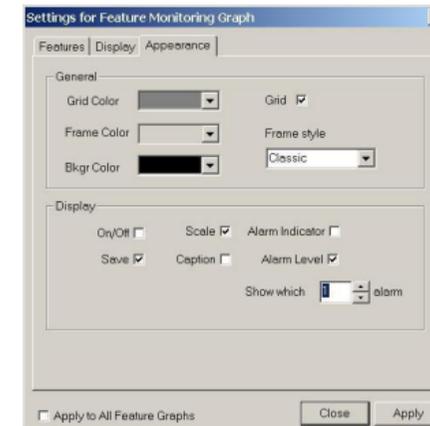
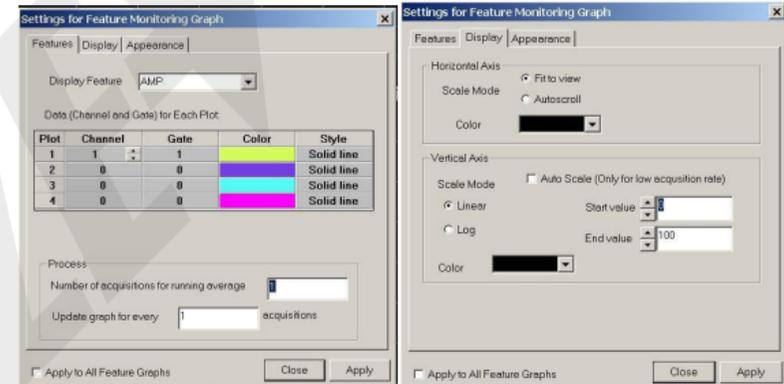


Figure 4.25: Feature Monitoring Graph Setup

Check the 'Apply to All A-Scan Graphs' to apply the settings to all A-Scan graphs. Otherwise it applies only to the current active graph.

4.8.2.2 Zoomed A-Scan Graph Setup

Figure 4.23 shows the zoomed A-Scan Graph setup dialog.

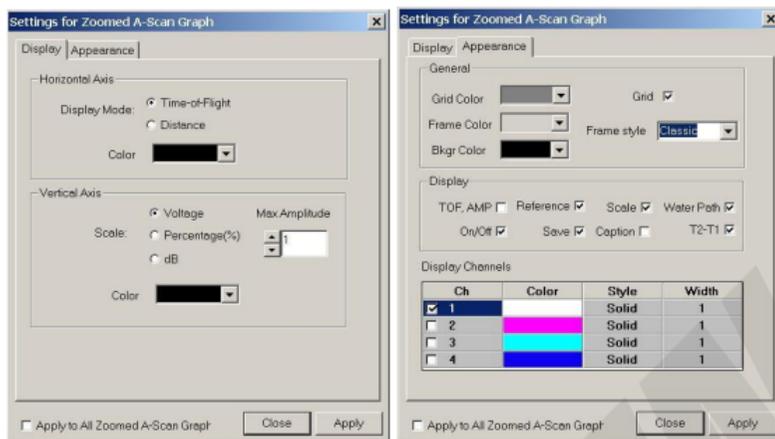


Figure 4.23: Zoomed A-Scan Graph setup.

The settings for Zoomed A-Graph are identical with the A-Scan Graph. Note: in the Zoomed A-Scan Graph, the scale for horizontal axis isn't related to the A/D delay and width, while in A-Scan Graph, the horizontal axis scale is determined by the A/D delay and width.

4.8.2.3 Spectrum Graph Setup

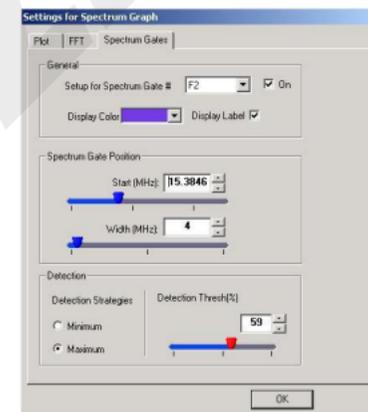
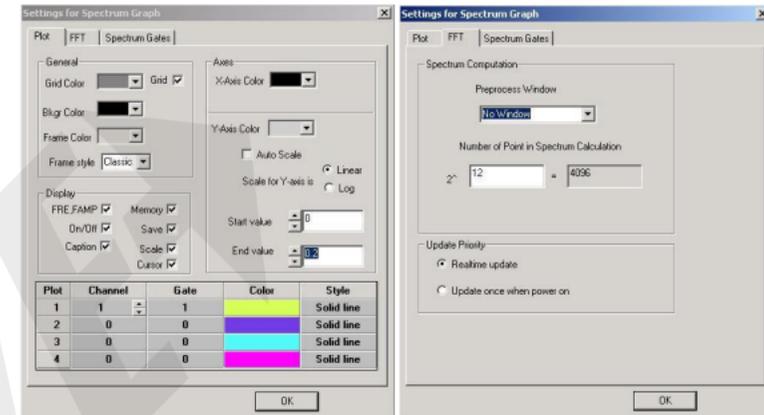


Figure 4.24: Spectrum Graph Setup

The spectrum graph setup includes three pages as shown in Figure 4.24.

In the 'Plot' page, you setup the appearance of the graph and plot. In the 'General' group, similar to other graph setup, you can modify the colors, grid and frame style. In the 'Axes' group, you change the color and scale for the X and Y axis. For Y-Axis, if the 'Auto Scale' is checked, the program will automatically adjust the minimum and maximum value of the axis based on the plot data. If it is not checked, you can manually input the Start (minimum) and End (maximum) values using the edit boxes. The scale for Y-Axis can be linear or log. Up to four spectrum plots can be displayed in one graph. In the table at the bottom of the page, you select the data source for each plot. The valid channel number is from 1 to the number of enabled channel. The valid time-domain gate index is from 1 to 4. A plot will be disabled if its channel or time-domain gate is invalid. Change the plot color and style by clicking the corresponding column.

4.8.2.5 B-Scan Graph Setup

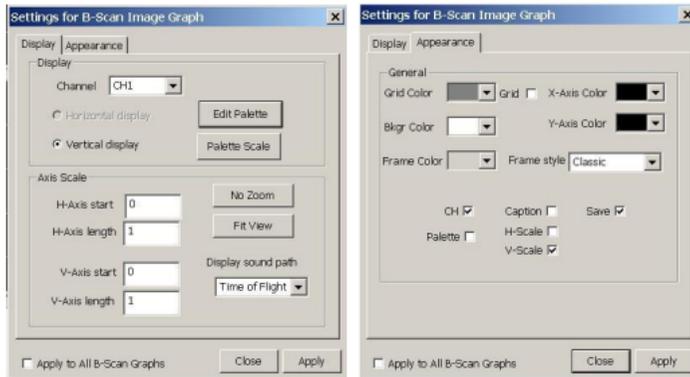


Figure 4.26: B-Scan Image Graph Setup.

We refer to B-Scan as a “through B-Scan”, which plots the entire waveforms vertically. Each vertical line on the B-Scan image corresponds to an individual waveform at an acquisition point. B-Scan is only available when the waveform is acquired.

There are two pages for the B-Scan Image Graph setup as shown in Figure 4.26.

In the ‘Display’ page, if you select ‘Horizontal Display’, the horizontal axis will be the sound path axis (waveform axis) and the vertical axis will be the scanning axis (this type of graph is called B'-Scan in UTwin). We refer to B'-Scan as a “through B'-Scan”, which plots the entire waveforms horizontally. Each horizontal line on the B'-Scan image corresponds to a waveform at an acquisition point. If the ‘Vertical Display’ is selected, the vertical axis becomes the sound path axis. Click the ‘Edit Palette’ button to edit the color palette and click the ‘Palette Scale’ button to change the scale on the palette bar. In the ‘Axis Scale’ group, there are several controls used to change the size of the image. Clicking ‘No Zoom’ button will change the plot scale to make each pixel presenting one acquisition data and the program will automatically set the scale of both H(X) and V(Y) axes based on B-Scan settings. Clicking ‘Fit View’ will enlarge or compress the image size to fit the graphic display area. You can manually change the scale for both H(X) and V(Y) axes using the four edit boxes. The unit for sound path axis can be time or distance.

In the ‘Appearance’ page, you change the appearance of the graph. As for all graphs, change colors for grid, frame, Bkgr(Background) by clicking the color box; select the frame style(Classic or 3D) from the drop list; check the Grid box if you want the grid to be visible. There is a group of check boxes which are used to toggle the visibility of the controls around the graph:

- CH – Channel button at the bottom of the graph.
- Palette – Palette bar at the left side of the graph.
- Caption – Show or hide caption for all axes.
- H-Scale – H-axis scale edit box.
- V-Scale – V-axis scale edit box.
- Save – a small button at the bottom of the graph. Click this button to save data or image in this graph.

4.8.2.6 b-Scan Graph Setup

b-Scan is a horizontal graph that plots the feature data. b'-Scan is a vertical graph that plots the feature data .

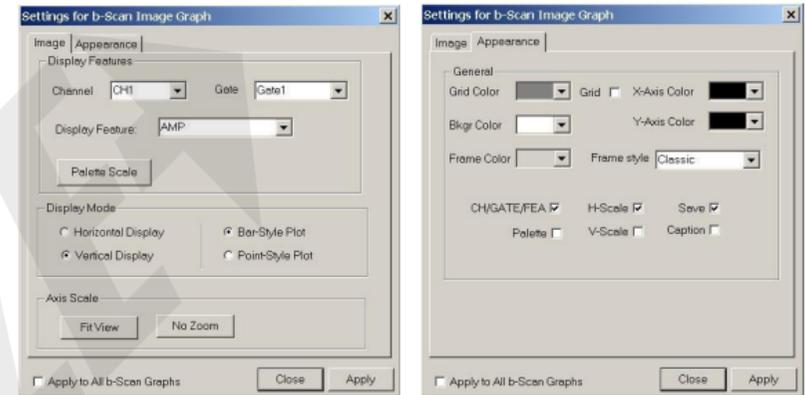


Figure 4.27: b-Scan Image Graph Setup

There are two pages for the b-Scan Image Graph setup as shown in Figure 4.27.

In the ‘Image’ page, you setup the data source by selecting channel, gate and feature name. Click the ‘Palette Scale’ button to edit the palette scale. In the ‘Display Mode’ group, if you select ‘Horizontal Display’, the horizontal axis will be the feature axis and the vertical axis will be the scanning axis. In this case the graph is called b'-Scan in UTwin. If the ‘Vertical Display’ is selected, the vertical axis becomes the feature axis. If the ‘Bar-Style Plot’ is selected, each feature data will be displayed as a rectangular bar. If the ‘Point-Style Plot’ is selected, each feature data is displayed as a color point. Clicking ‘No Zoom’ button will change the plot scale to make each pixel presenting one acquisition data and the program will automatically set the scale of both H(X) and V(Y) axes based on B-Scan settings. Clicking ‘Fit View’ will enlarge or compress the plot size to fit the graphic display area.

In the ‘Appearance’ page, you change the appearance of the graph. As for all graphs, change colors for grid, frame, Bkgr(Background) by clicking the color box; select the frame style(Classic or 3D) from the drop list; check the Grid box if you want the grid to be visible. There is a group of check boxes, which are used to toggle the visibility of the controls around the graph:

- CH/GATE/FEA– Channel, gate and feature buttons at the bottom of the graph.
- Palette – Palette bar at the left side of the graph.
- Caption – Show or hide caption for all axes.
- H-Scale – The H-axis scale edit box.
- V-Scale – The V-axis scale edit box.
- Save – A small button at the bottom of the graph. Click this button to save data or image in this graph.

4.8.2.7 Feature Image Graph

The Feature Image Graph is a pseudo 2D presentation of the B-Scan (1-D) data in a 2D format as C-Scan Graph. The 1-D data are plotted as a 2-D color image. In this image, each acquisition point is plotted as a solid rectangle, as the number of acquisitions increase, the solid rectangles are stacked along the horizontal axis as the number of data acquisition increases. Once the plot reaches the end of the horizontal axis, it will automatically increase the 'index' and plot data in the next image line.

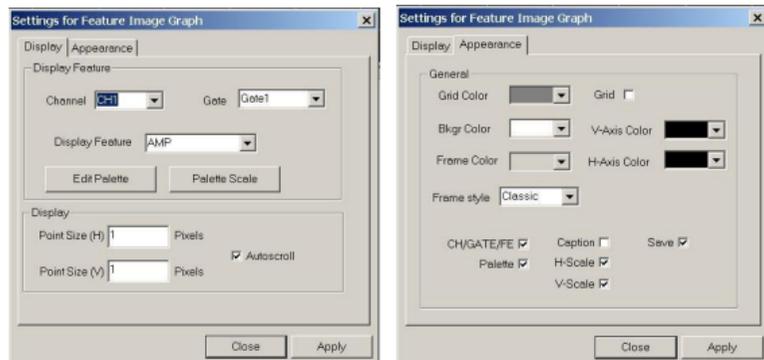


Figure 4.28: Feature Image Graph Setup

There are two pages for the Feature Image Graph setup as shown in Figure 4.28.

In the 'Display' page, you setup the data source by selecting channel, gate and feature name. Click the 'Palette Scale' button to edit palette scale and use 'Edit Palette' to change palette colors.

In this graph, each data is presented as a colored rectangle; the size of the rectangle is given in number of screen pixel. You can change its horizontal (H) and vertical (V) size by directly inputting the value in the edit boxes. When the 'Autoscroll' checkbox is enable, the plot will scroll when the plot area is complete filled during real-time acquisition.

The functions in the 'Window' page are very similar to that for the b-Scan graphs

4.8.2.8 Gate Feature Table

The Gate Feature Table allows the user to monitor any and all types of features being processed by the UT instrumentation. The information is in a table format listing offering an additional monitoring capability over the graphing of UT data.

The Gate Feature Table can be used in acquisition or replay, and offers the same flexibility in both, however, it is recommended to use this mode sparingly in acquisition as its use might slow down the data acquisition speed by a significant amount. It is therefore recommended to use this when data acquisition rates are low, before a test as a prescreening method or after a test in replay.

	Gate1	Gate2	Gate3	Gate4
CH1	100.0	26.3	1.5	86.1
Gate Feature Table AMP				
	Gate1	Gate2	Gate3	Gate4
CH1	0.300	2.517	6.468	1.380
Gate Feature Table TOF				

Figure 4.29: Gate Feature Table.

4.8.2.9 Noise and SNR Table

Under the 'Analysis' menu, select 'Noise and SNR' to create a Noise and SNR view table as shown in Figure 4.30. The table includes two rows and several columns. Each column represents results for one gate. The first row shows the RMS (Root Mean Square) for the waveform within the gate. The second row shows the SNR of the signal within the gate. The SNR is calculated based on: $SNR = 20\log(\text{peak amplitude within the gate/system noise level})$. You can select the RMS within any gate as the system noise level using the 'System noise level is determined by' dropdown list. For a multiple channel system, you can open multiple tables and each table shows results for one channel.

	Gate1	Gate2	Gate3	Gate4
RMS	0.0080	0.0043	0.0047	0.0044
SNR	41.9839	0.0000	0.0000	0.0000
System noise level is determined by Gate1 0.007958				
Show results for Channel CH1				

Figure 4.30: Noise and SNR (signal-to-Noise Ratio) Table.

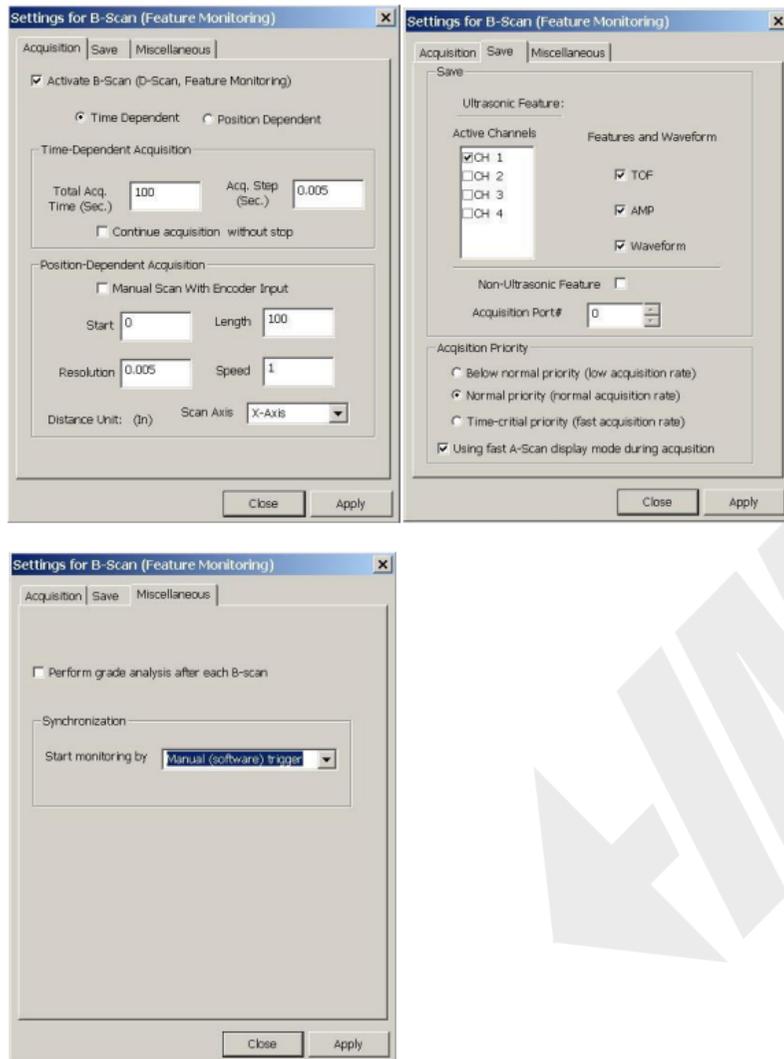


Figure 4.31: B-Scan (Feature Monitoring) Settings.

4.9 B-Scan (Feature Monitoring)

4.9.1 B-Scan (Feature Monitoring) Settings

Click the B-Scan Settings button to open the Settings for B-Scan (Feature Monitoring) dialog as shown in Figure 4.31. In this setting, there are three pages:

In **Acquisition** page, you input scanning settings

Activate Feature Monitoring (B-Scan): Check this box to activate B-Scan mode. If B-Scan mode is activated, the acquisition control toolbar (Start, Stop, Pause, Resume) will be appended to the A-Scan toolbar.

Time Dependent: In this mode, the acquisition is controlled by a timer. If this option is selected, the controls inside the Time-Dependent Acquisition group will be enabled, thus you can input the following:

Total Acq. Time (Sec.): Total duration of data acquisition.

Acq. Step (Sec.): Acquisition step.

Continue acquisition without stop: If checked, the acquisition can be stopped only when you click the Stop button

Position Dependent: In this mode, the acquisition is controlled by encoders or scanners. If this option is selected, the controls inside the Position-Dependent Acquisition group will be enabled, thus you can input

Start: Scanning start position.

Length: The length of the scanning axis. This is the distance over which data needs to be acquired.

Resolution: Resolution is the distance between two neighboring data acquisition points along the scan axis.

Speed: Besides the mechanical reasons that impose an upper speed limit on the scanner, other factors such as index size, scanning area, sampling record size and sampling frequency also constrain the maximum speed that can be used for a successful scan image. If the speed is set too high, data will be missing and will appear as gaps on the scan graph.

Scan Axis: You can select X, Y, Z, or T axis as the scanning axis.

Check the 'Manual scan with encoder input' if that is a manual scan and only encoder input is used.

In the 'Save' page:

You can select the features and waveform to be saved. If the boxes for feature data (TOF, AMP and Waveform) are not checked, then that feature or waveform data will not be saved. In the Active Channels list, check the channel you want to acquire and save.

In this page, you can also select the task priority for data acquisition. If you are doing time-critical data acquisition and don't want other window tasks to interrupt your data acquisition, you can select Time-critical priority. In this case the program may not respond to your mouse and keyboard message during acquisition.

Miscellaneous Page:

In this page, you can select the trigger source for starting data acquisition. If your data acquisition needs to be synchronized with some other events, you can select Hardware Trigger and provide external trigger. Otherwise just select Software Trigger, i.e. click the start button to start acquisition. If 'Perform grade analysis after each B-scan' is checked, grade analysis will be automatically performed and displayed after each B-scan.

4.9.2 Pause, Resume, Abort The B-Scan (Feature Monitoring) Test

The Pause, Resume and Abort functions are provided on the Acquisition Icon in the A-Scan toolbar as shown in Figure 4.1. The icons are fashioned after similar visual controls used in the Audio tape recorder business. To pause your test, simply press the Acquisition icon labeled **Pause**. In pause you can see the test status box change to "Test Paused". At this point, the system will stop collecting UT data, but the test will not be exited. Someone might want to Pause during a test to ignore some event that might add noise to the test. To resume, just press the **Resume** icon button located next to the Pause button. This restarts acquisition. To abort the test, simply click the button labeled **Abort**. Selecting this function stops the test. The abort function was convenient in those cases where the user wanted to quickly stop a trial test.

During real-time B-Scan, you can

- press the 't' key to record time mark. The time marks are displayed in the feature monitoring graph as vertical lines with 'W' labels.
- switch between pages using "Page UP" or "Page Down" keys.

4.10 Data Save in A-Scan Mode

There are several ways to save different type of data in A-Scan mode. Usually on each graph, there is a save button (if the button is not visible, you can toggle it in the graph setup dialog). Clicking this save button will bring up a file saving dialog to save data related to that graph. For example, for A-Scan graphs, you can save waveform data in ACSII format and save the graph in Bitmap (BMP) or Jpeg (JPG) format. For B-Scans and feature monitoring graphs you can save B-Scan data and the image in Bitmap (BMP) or Jpeg (JPG) format. You can click the save button in the main toolbar to start data saving. Clicking this button is equivalent to clicking the saving button on the current active graph.

5. OPERATING UTwin – C-SCAN MODE

To enter C-Scan mode, click the **C-Scan** tool button or select **CScan->Start**. The C-Scan toolbar (see figure 5.1) will be shown under the main toolbar. In C-Scan mode, you can configure the C-scan settings for a particular test and perform a C-Scan (2-D scan).



Figure 5.1: C-Scan Toolbar.

5.1 Graphs in C-Scan

In C-Scan mode, all the graphs described in the A-Scan mode can also be created in C-Scan mode. In addition to all graphs in A-Scan mode, you can create C-Scan Image Graphs in C-Scan mode like that shown in figure 5.2.

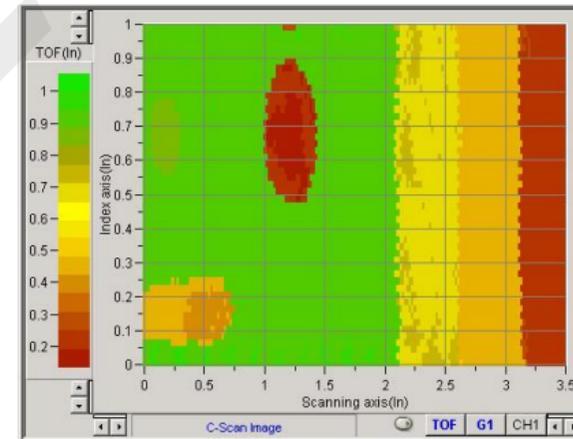


Figure 5.2: C-Scan Image Graph.

5.1.1 Graph Setup in C-Scan

5.1.1.1 C-Scan Image Graph Setup

There are two pages for setting up the C-Scan Image Graph as shown in Figure 5.3.

In the 'Image' page, you setup the data source by selecting channel, gate and feature name. Click the 'Palette Scale' button to edit palette scale and use 'Edit Palette' to change palette colors.

In the 'Axis Scale' group, there are several controls used to adjust the image size. Clicking the 'No Zoom' button will change the plot scale to make each pixel represent one acquisition data point and the program will automatically set the scale of both H(X) and V(Y) axes based on C-Scan settings. Clicking 'Fit View' will enlarge or compress the image size to fit the graphic display area. Check the 'Aspect ratio' to keep the image's aspect ratio when zooming the image. Check the 'Auto Scroll' to enable the scrolling function during real-Time C-Scan. You can also directly change the scales by inputting the "start" and "width" in the four edit boxes.

Further, the data can be plotted in Polar or Cylindrical formats by clicking on the desired option. The Polar display is available only when the turntable (T-Axis) is used, either as scanning or index axis during C-Scan.

In the 'Appearance' page, as for all graphs, you can change colors for the grid, frame, and Bkgr(Background) by clicking the color box; select the frame style(Classic or 3D) from the drop-down list; check the Grid box if you want the grid to be visible. There is a group of check boxes which are used to toggle the visibility of the controls around the graph:

- CH /GATE/FE** – Channel , gate and feature buttons at the bottom of the graph.
- Palette** – Palette bar at the left side of the graph.
- Caption** – Show or hide caption for all axes.
- H-Scale** – H-axis scale edit box.
- V-Scale** –V-axis scale edit box.
- Save** – A small button at the bottom of the graph. Click this button to save data or image in this graph.

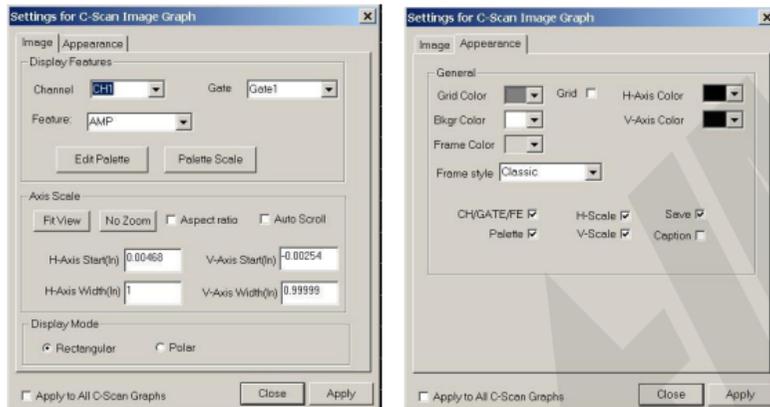


Figure 5.3: C-Scan Graph Setup

5.2 C-Scan Settings

Click the C-Scan Settings button to open the Settings for C-Scan dialog. In this setting, there are three pages as shown in Figure 5.4:

In the 'Scan Area' page, you setup scanner related parameters

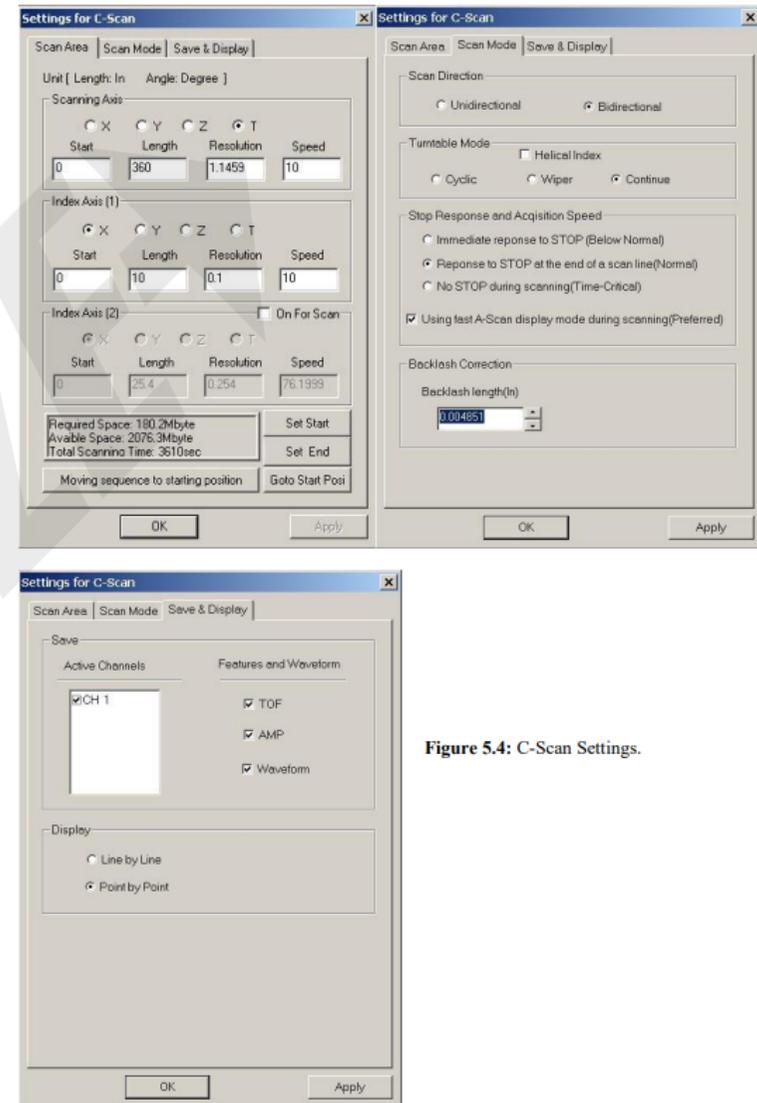


Figure 5.4: C-Scan Settings.

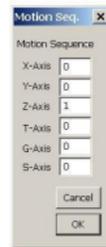


Figure 5.5: Motion Sequence Dialog.

Scan Axis - Any one of the three axes (X, Y, Z and Turntable) can be chosen as the scanning axis. The scan axis is the primary axis over which the data is acquired. The Scan axis is the one which continuously moves from end to end during a test. The X-axis is normally chosen as the scanning axis. Regardless of any axis chosen, data of the scanning axis is represented by the horizontal lines on the C-Scan screen.

Index Axis(1) - Any one of the four axes (X, Y, Z and Turntable) can be chosen as the indexing axis (1). The index axis is the axis that moves a small distance at the end of each scan line in a C-Scan. In contour following, the index axis is represented by a file which stores the coordinates for all axes.

Index Axis(2) - Any one of the four axes (X, Y, Z and Turntable) can be chosen as the indexing axis(2). The Index(2) axis is typically used when performing slope scanning. It allows 2 axes to be indexed at the end of a scan. To enable this axis, the “on for scan” should be checked.

Scan Start - The scanning start position is at the origin (0,0,0,0,0) of the scanner. If the start position should be different from the origin, then it should be set so. X, Y, Z, T, G and S are for six axes.

Length - The length of each axis in the software (scan, index and jog) is the distance over which data needs to be acquired. The scan length must be set so as to prevent the scanner from crashing into the side wall of the tank. For the X,Y and Z axis, this measurement is in inches or millimeters, and for the Turntable, this measurement is in terms of degrees.

Resolution - Resolution is the distance between two neighboring data acquisition points along the scan and index axes. The finest resolution permitted is determined by the motion parameters of the scanner.

Speed - Besides mechanical reasons that limit the upper speed of the scanner, other factors such as index size, scanning area, sampling record size and sampling frequency also dictate the maximum speed that can be used for a successful image scan. If the speed is set too high, data will be missing and will appear as gaps on the scan image.

Set Start – Click this button to set current motor position as the C-scan starting position.

Set End – Click this button to set current motor position as the C-scan end position. The scan and index lengths are automatically updated based on scanning start and end positions.

Moving sequence to starting position - Click this button to open the Motion Sequence Dialog as shown in Figure 5.5. In this dialog, you can setup the moving sequence for each axis when motors move to the starting position. Axes with low

Goto Start Posi. – Click this button to move motors to the C-scan starting position.

The ‘Scan Mode’ page is used to setup the scanning method. This page contains setup controls for the scanner direction, turntable mode direction, stopping mode and backlash corrections.

Scan Direction - Choose between unidirectional scanning, for which data are acquired only for the forward (start to end) direction, or Bi-directional scanning, for which data are acquired for both forward and return directions. Unidirectional is used if there is a concern about backlash in the UT system.

Turntable Mode - The turntable can be operated in three modes – Cyclic, Wiper and Continuous modes. “Cyclic” means that the turntable will stop and index but continue to rotate in one direction upon each 360° index angle, while in “Wiper” mode the turntable will alternately change direction at each 360° index angle. “Continue” is a continuous mode that the turntable will continuously move in one direction never stopping.

The helical index is used for continuous turntable mode. When this is checked, the index axis will move continuously as the turntable is moving. The index axis’ speed is synchronized in a way such that every 360-degree on the TT axis, the index axis will move exactly the one full index resolution. When the SMC-PCI board is used, the acquisition/index axis moving, starts only when the Turntable’s full speed is reached.

Stop Response(Priorities) – Select ‘Immediate response to STOP’ to let the program check the STOP message (mouse click or keyboard input) during scanning. A ‘Stopping’ text will be immediately posted in the status bar when the STOP message has been received. But the motor may continue moving to the end of the scanning line in some the scanning modes. If the ‘Response to STOP after one scan line’ is selected, the program will process the STOP message, only at the end of one scanning line. The program will not respond to a STOP message during C-Scan if the ‘No STOP during scanning’ is selected. In high speed C-scan, it is recommended to use the fast A-Scan display mode.

Backlash length- Backlash correction is provided to avoid image distortion due to backlash in the UT system if bidirection mode is used. Clicking on the arrow keys to change the value of the correction distance.

In the ‘Save & Display’ menu page, you can decide the desired display and acquisition choices. You can select the features and waveform to be saved. If the boxes for feature data (TOF, AMP and Waveform) are not checked, then that feature or waveform data will not be saved. In the Active Channels list, check the channel you want to acquire and save data.

Display - Choose between a ‘Point-by-Point’ data acquisition (and display) or a ‘Line-by-Line’ data acquisition (and display). A line by line saves and buffers all points in the line during a scan and then displays the entire line at the end of the scan.

5.3 Go, Pause, Resume, Abort The C-Scan Test

The Pause, Resume and Abort functions are provided on the Acquisition Icon in the C-Scan toolbar as shown in Figure 5.1. By pressing the ‘Go’ button, the actual scanning and data acquisition can be performed in real time. An image is displayed in the C-Scan window based on the gated information chosen in the Acquire window. By pressing the Pause button, the scanner can be stopped temporarily and a Resume button appears. By pressing the Resume button, the scan will continue from where it left off. By pressing the Stop button, the current scan can be aborted.

During real-time C-Scan, you can

- switch between pages using “Page UP” or “Page Down” keys. **Pages will be switched at the end of one scanning line.**

5.4 Data Save in C-Scan Mode

There are several ways to save different type of data in C-Scan mode. Usually on each graph, there is a save button(ifthe button is not visible, you can toggle it using the graph setup). licking this save button will bring up a filesaving dialog to save data related to that graph. For example, for the C-Scan graph you can save C-scan data andthe image in Bitmap (BMP) or Jpeg (JPG) format. You can click the save button in the main toolbar to start datasaving. Clicking this button is equivalent to clicking the saving button on the current active graph.

6. OPERATING UTwin – REPLAY MODE

To switch to Replay mode, click on the Replay in the UTwin™ menu. You can also click the ‘Open’ button in the main toolbar to replay the data you want and after the data is opened, replay mode will automatically start. In replay mode, a replay toolbar will be displayed under the main toolbar as shown in Figure 6.1.



Figure 6.1: Replay Toolbar

6.1 Graphs in Replay Mode

In replay mode, all the graphs described in A-Scan and C-Scan modes can also be created in replay mode. In addition to all graphs in A-Scan and C-Scan modes, you can create many other graphs and tables such as 3D graphs which can be zoomed and rotated in any direction, cluster and statistics tables. We will discuss these graphs and tables in future sections of this manual.

6.2 B-Scan and C-Scan Table View

To quantitatively present B-Scan or C-Scan data, UTwin provides B-Scan and C-Scan table views as shown in Figure 6.2 and 6.3. In table views, gate features are presented as digital numbers.

Figure 6.2 shows the B-Scan table view. In this table, each column represents one enabled gate and each row shows the gate feature for one acquisition point. You can change the feature and channel index using the two buttons at the bottom of the table. The cell with green background color indicates the position of the cursor in the B-Scan Image or Feature Graph. As you move the cursor in these graphs, data in the table will be automatically updated and the cursor position will be always at the center of the table. The cell with red background color has a minimum value and the cell with blue background color has a maximum value. Select “Table/Graph Setup” in the Main Menu to open the table setup dialog as shown in Figure 6.4. In this dialog, you can change the scale for amplitude or time-of-flight and revise the number of row in the table.

Figure 6.3 shows the C-Scan table view. In this table, the first row shows the scanning position and the first column shows the index position. You can change the feature, gate and channel indices using the three buttons at the bottom of the table. The cell with green background color indicates the position of the cursor in the C-Scan Image Graph. As you move the cursor in this graph, data in the table will be automatically updated and the cursor position will be always at the center of the table. The cell with red background color has a minimum value and the cell with blue background color has a maximum value. Select “Table/Graph Setup” in Main Menu to open the C-Scan table setup dialog as shown in Figure 6.5. In this dialog, you can change the scale for amplitude or time-of-flight and revise the number of row and column in the table.

	Gate1	Gate2	Gate3	Gate4
5.350	19.5	69.1	11.7	24.4
5.400	18.0	67.1	11.5	25.9
5.450	17.1	68.7	12.1	23.4
5.500	19.1	66.7	11.4	23.8
5.550	19.2	70.8	10.2	23.1
5.600	20.3	68.3	12.1	24.1
5.650	19.0	70.7	9.5	22.2
5.700	17.3	70.9	10.8	25.8
5.750	18.5	69.1	10.6	24.0
5.800	17.8	68.8	10.5	24.1
5.850	17.0	67.9	11.3	24.9
5.900	19.2	68.7	10.9	24.6
5.950	17.4	69.1	11.4	23.9
6.000	17.7	68.6	11.2	22.0
6.050	17.8	69.3	11.6	23.5

B-Scan Feature Table AMPI CH1

Figure 6.2: B-Scan Table View.

Y\X(In)	2.265	2.280	2.295	2.310	2.325	2.340	2.355	2.370	2.385
0.525	46.0	57.4	65.5	66.4	63.0	54.5	47.2	45.1	44.3
0.540	17.0	54.5	63.8	66.4	67.7	69.4	67.7	65.5	63.8
0.555	14.5	51.5	58.3	63.0	64.7	66.8	67.7	66.8	64.7
0.570	16.2	35.7	44.3	47.2	50.6	52.3	54.5	54.5	56.2
0.585	18.7	39.6	49.8	56.2	60.0	61.7	63.0	62.1	61.7
0.600	19.1	43.4	54.5	61.7	66.8	66.8	66.4	65.5	66.4
0.615	19.1	41.3	52.3	60.8	61.7	56.2	47.2	46.0	46.0
0.630	15.3	12.3	52.8	57.4	51.5	37.4	23.4	21.7	22.6
0.645	16.2	11.5	51.5	57.4	52.3	40.4	30.2	28.5	28.5
0.660	7.7	12.3	52.8	57.4	60.8	57.4	56.2	53.6	54.5

C-Scan Data Table AMPI G1 CH1

Figure 6.3: C-Scan Table View.

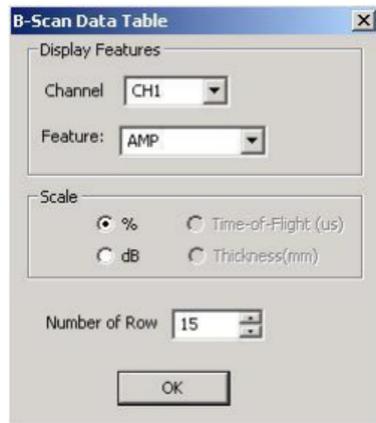


Figure 6.4: B-Scan Table View Setup Dialog.

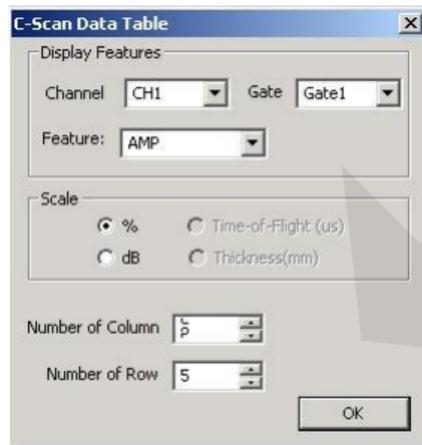


Figure 6.5: C-Scan Table View Setup Dialog.

6.3 Batch File Process

To simplify and speed up the processing of a number of acquired data files, UTwin provides a function called batch file process to simultaneously open several data files or all data files in one folder. To use this function, in the Replay menu, select Batch File Process to bring up the Batch File Process Dialog as shown in Figure 6.6. In this dialog, you can select the type of data file (either B or C-scan data) from the 'File Type' drop list. To open one or several files, click the 'Insert Data Files' button to bring up the standard File Open dialog in which you can select data files (Press CNTRL to select multiple files in the file open dialog). To open all data files in one folder, click the 'Open Data Folder' button to bring up the standard directory open dialog. All selected data files are listed in the 'List of Data Files' box and the directory of the first data file is shown on the top. After data files have been opened, to view a specific data file, simply select it from the 'List of Data Files' box. If the 'Clean all graphs after changing file selection' is not checked, then the annotations in images are kept when switching between data files. In this case you can perform cluster, statistics and image analysis for the same selected area for all data files. Click 'Empty Data File List' button to open the list.

6.4 Annotations

Clicking the 'Annotation' tool button brings up a floating Annotation toolbar (Figure 6.7), which allows you to insert annotations (text, shape) to any graph. There are several buttons in the Annotation toolbar. Select 'Modification' button to change the annotation properties (font, shape, position ...) in a graph. In this mode, you move the mouse over the annotation you want to modify. The shape of the cursor will change when the annotation is in focus. Then you can drag the annotation to change its size, position and shapes. Using the 'Add Text' to add text. Using the 'Arrowed-Line' to draw a line and using the 'Circle', 'Rectangle' and 'Polygon' to draw shapes. If the 'Delete' button is selected, once you move

over an annotation, the cursor shape will change from an arrow to a hand and click the left mouse button to delete the selected annotation. When 'Paste' is selected, you can paste the selected annotation at current cursor position. The boundary of the selected annotation is outlined by dotted lines. You can also use CNTRL+V keys to perform paste directly. Figure 6.8 shows an example of annotations on a C-Scan image graph. You can double click an annotation to bring up a setup dialog to configure the annotation. Figure 6.9 shows the setup dialogs for a rectangle annotation. In the 'Settings' page, you can input comment regarding this annotation. The comment can be exported to report (See section 7.4 about Report Option). The size and position edit boxes are used to change the annotation shape numerically. In the 'Style' page, you can modify the appearance of the annotation such as line width and color.

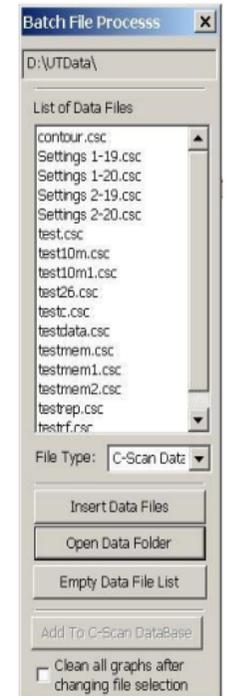


Figure 6.6: Batch File Process Dialog.



Figure 6.7: Annotation Floating toolbar.

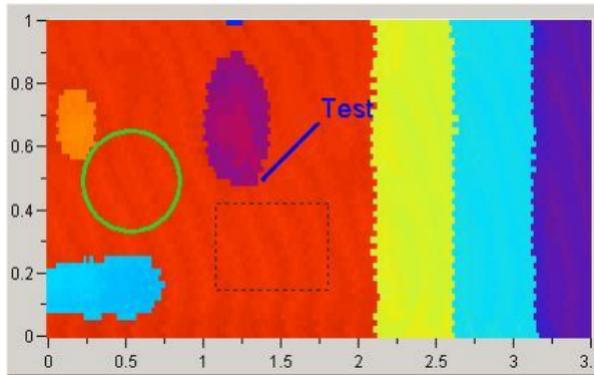


Figure 6.8: Example of annotations including text, line and shapes.

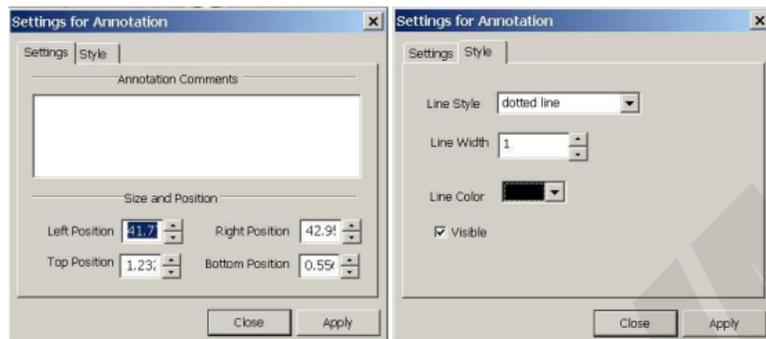


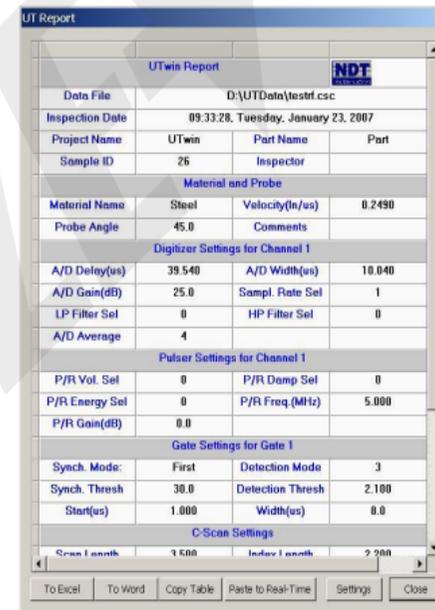
Figure 6.9: Example of setup dialogs for a rectangle annotation.

6.5 Report and Paste UT Settings

Clicking on the Report button brings up the Test Report dialog (Figure 6.10a), containing important setup information on current replaying project, Pulsar/Receiver, Digitizer, Gates and Scanner. The information is automatically carried over from your actual test settings. At the bottom of the dialog, there are several buttons. Click 'To Excel' to export the table to Microsoft Excel and 'To Word' to export it to Microsoft Word. Click 'Copy Table' to record the data into clipboard and then the table can be pasted into any program. The 'Paste to Real-Time' button allows you to import all the settings associated with the opened data file being viewed, including its scanner configuration, its UT hardware setup parameters, and its scanning setup parameters, into real-time data acquisition. Click the 'Settings' button to bring up the report settings dialogs shown in Figure 6.10b.

Besides the dialog views for UT settings shown in Figure 6.10, UTwin also provides table style views for UT settings as shown in Figure 6.11. For table views, you can copy and paste the data in the table to any program and export to Word/Excel(See section 7.4 about Report Option). To perform table copy, right click the table and a pop-

up menu will appear, from the menu, you can select 'Copy All' or 'Copy Selected'. Select 'Graph Setup' menu item to open the setup dialog shown in Figure 6.10. In this dialog, you can change the background color of the table cells.



(a)



(b)

Figure 6.10: (a) Report Dialogs. (a) Settings for Report Dialog.

Data File	D:\UTData\Settings 2-19.csc		
Inspection Date	16:17:26, Tuesday, December 19, 2006		
Project Name	UTwin	Part Name	Part
Sample ID	19	Inspector	
C-Scan Settings			
Scan Length	1.000	Index Length	1.000
Scan Res.	0.010	Index Res.	0.010
Scan Speed	3.000	Index Speed	3.000
Scan Axis	0	Index Axis	1
2th Index	OFF		
TOF Save	Yes	AMP Save	Yes
Waveform Save	Yes		

Channel: 1			
A/D Delay(us)	0.000	A/D Width(us)	40.08
A/D Gain(dB)	20.0	/D Rate Selectio	0
A/D Average	1	/D Trig. Selectio	0
A/D LP Filter Sel	0	A/D HP Filter Se	0
A/D DAC	OFF		
A/D AGC	OFF	A/D AGC(%)	80.0
Channel: 2			
A/D Delay(us)	0.000	A/D Width(us)	30.00
A/D Gain(dB)	20.0	/D Rate Selectio	0
A/D Average	1	/D Trig. Selectio	0
A/D LP Filter Sel	0	A/D HP Filter Se	0
A/D DAC	OFF		

Channel: 1			
P/R Vol. Sel	0	P/R Damp Sel	0
P/R Energy Sel	0	P/R Freq.(MHz)	5.000
P/R Gain(dB)	0.0	Inspector	
P/R LP Filter Sel	OFF	P/R HP Filter Se	OFF
Channel: 2			
P/R Vol. Sel	0	P/R Damp Sel	0
P/R Energy Sel	0	P/R Freq.(MHz)	5.000
P/R Gain(dB)	0.0	Index Axis	1
P/R LP Filter Sel	OFF	P/R HP Filter Se	OFF
Channel: 3			
P/R Vol. Sel	0	P/R Damp Sel	0
P/R Energy Sel	0	P/R Freq.(MHz)	5.000
P/R Gain(dB)	0.0		

Channel: 1				
Gate1	Gate2	Gate3	Gate4	
Gate Status:	ON	ON	ON	ON
Synch. Mode:	Initial	Initial	Initial	Initial
Synch. Thresh	50.0	50.0	50.0	50.0
Detection Mode	3	3	3	3
Detection Thresh	3.0	6.9	13.4	27.0
Start(us)	2.080	2.798	1.080	0.960
Width(us)	3.000	3.000	3.000	3.000
Channel: 2				
Gate1	Gate2	Gate3	Gate4	
Gate Status:	ON	ON	ON	ON
Synch. Mode:	Initial	Initial	Initial	Initial

Figure 6.11: Report Tables.

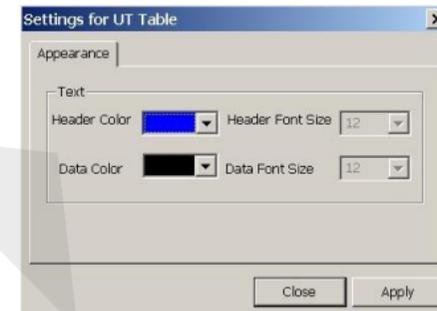


Figure 6.12: Setup dialog for UT Setting Table.

6.6 3D C-Scan Image Graph (optional)

A 3D C-Scan Image Graph is available in UTwin software as an option. Any standard (2 dimensional) C-Scan image can be displayed as a 3-D projection (as that shown for a test block in Figure 6.13. below) simply by selecting 3-D Graph from the replay toolbar.

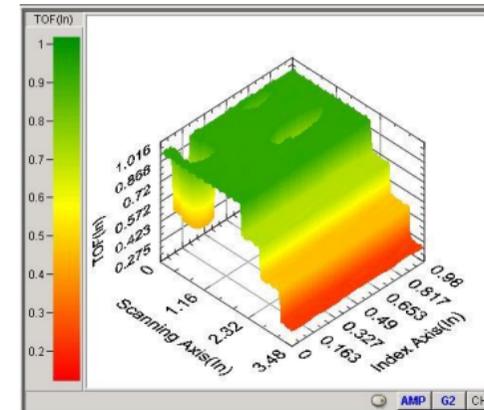


Figure 6.13. 3D Graph

Zooming, Panning and Rotation of 3-D graphs can be accomplished but not in the same way as that for 2-D graphs. For 3-D graphs, this requires a combination of the mouse and keyboard manipulations to accomplish.

Rotating the graph is the easiest function. All you need to do is place your mouse pointer somewhere near the middle of the 3-D graph, press the left mouse button and while holding the left mouse button down, move the mouse slightly around in a circle. You will see the rotation of the graph change. You can position it anywhere you want.

To zoom, simply place the mouse pointer somewhere near the center of the 3-D graph and when ready, press the ALT button on the keyboard, and while holding that down, press and hold the left mouse button down. Then slightly move the mouse down (while holding the ALT button and the left mouse button depressed). As you move the mouse down the 3-D graph will zoom. As you move the mouse up, the graph will shrink.

To pan the 3-D graph, place the mouse pointer somewhere near the center of the 3-D graph, depress and hold the SHIFT button on the keyboard down and at the same time depress and hold down the mouse left button. Then slightly move the mouse around to see the graph pan.

6.7 Clustering Setup and Operation (Optional)

The purpose of clustering is to automatically identify and associate smaller data groups within a scan area that meet user-controlled clustering criteria. These clusters are drawn on an image screen around the data to visually identify region(s) with user-defined defects. Cluster data can also be shown in a tabular form, allowing a quantitative assessment of the C-Scan data. Clustering offers the user computer-aided processing to identify regions of user-defined defects. Cluster analysis (Clustering) can be activated on any C-Scan image plot. The clustering can be turned on and configured from the Analysis menu or the 'Cluster Analysis' tool button. The steps in setting up and running a clustering application are defined below.

Step 1. Set up your C-Scan Image graph and configure it to make sure it meets your requirements.

Step 2. Next we must configure the clustering function. The cluster setup dialog includes two pages as shown in Figure 6.14. There are several clustering related parameters to be adjusted. This includes setup of the cluster size, threshold, and display options. Each of these is described further below.

Analysis Feature: Feature name of the data for analysis. This feature name, together with the channel number and gate index are determined by the C-Scan Image setting (Step 1). If you want to change the data source for cluster analysis, you need to close the setup dialog and go back to Step 1 to setup the image with the data source you want.

Threshold Value: Two thresholds are used to test whether a data point belongs to a cluster or not. The lower and upper thresholds are indicated by the red line in the threshold indication graph. Drag the black rectangle at the two ends of the red line to change the threshold values. The scale of the threshold graph is identical with the palette scale in the C-Scan Image graph

Minimum Cluster Size: Specify the minimum size (pixels) for a cluster. A group of pixels, which satisfy the above threshold and neighborhood conditions, containing the numbers of pixels more than the **Minimum Cluster Size** will be classified as cluster.

Cluster Neighborhood: Specify the separation of pixels within a cluster. If the nearest distance between two clusters is less than **Cluster Neighborhood**, then the two clusters are considered to be one cluster.

Analysis Region: Select 'Whole C-Scan Data' to perform cluster analysis for the whole image. Select 'Selected C-Scan Data (Visible Region in the Graph)' to perform cluster analysis for the region determined by the scale of the C-Scan graph. Thus in this option, you change the C-Scan scale to select the region you want to perform analysis.

Step 3. Now we are ready to run a test by clicking the 'Do Calculation' button. When the 'Do Calculation' button is clicked, an image processing algorithm is applied to the data pixels to find clusters satisfying the thresholds and minimum size conditions specified above. Clustering results will be tabulated by the software.

The 'Display' page provides tools to view the cluster results

Check the 'Show cluster annotations on the image' box to display the cluster annotations on the C-Scan image. The cluster annotation is a text with a format of "C#" (# is the cluster index). The cluster annotations are initially positioned at the center position of the cluster. Change the text color using the color box. Figure 6.15 show an example of C-Scan Image graph with cluster annotations.

Check the 'Indicate cluster boundary on the image' to outline the cluster boundary with the specified color.

Click 'Add Cluster Table' to bring up a table view with the tabulated clustering results as shown in Figure 6.16. The table shows a cluster by its index, location, amplitude and area. The Cluster table has the following columns. The leftmost shows the cluster ID, this is the identification number assigned when the cluster was formed. Next is the center position which includes coordinates of Y-Axis (Index Axis), X-Axis (Scanning Axis) and depth ('THK'). The next column is amplitude which includes minimum, maximum and average amplitude of the cluster. The last column is the area of the cluster (The number inside the semicolon presents the percentage related to total analysis area). At the bottom of the cluster table, inside the information bar, the total area and percentage of clusters with the area above threshold 1 (CA1) and threshold 2 (CA2) are displayed. You can change the threshold values in the clustering setup dialog shown in Figure 6.14.

Inside the table, right clicking the mouse will bring up a popup menu. Select the 'Table Setup' menu item to configure the table.

When the 'Save' button at the bottom of the table is clicked, a file saving dialog will be displayed and input the file name to save the results. The cluster table is saved in an ASCII format.

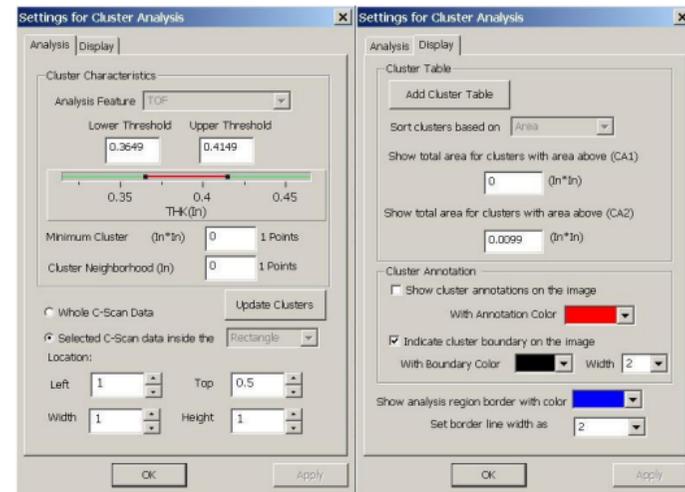


Figure 6.14: Clustering Setup Dialog.

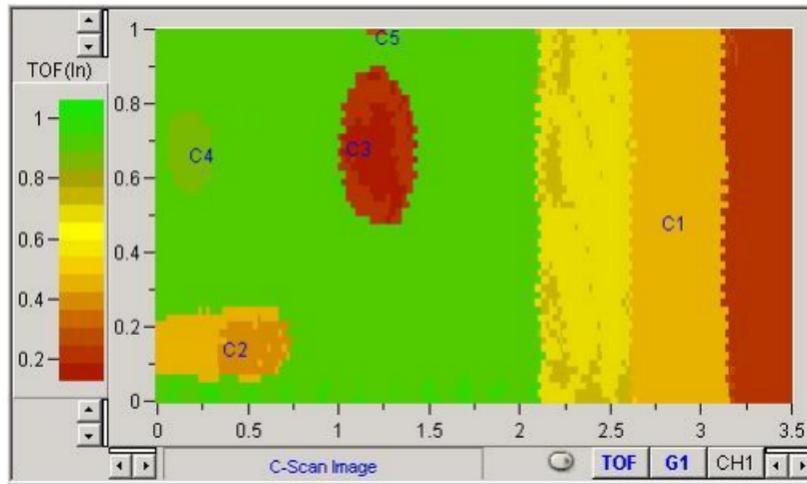


Figure 6.15: Example of Cluster Analysis: Cluster Annotations on Image.

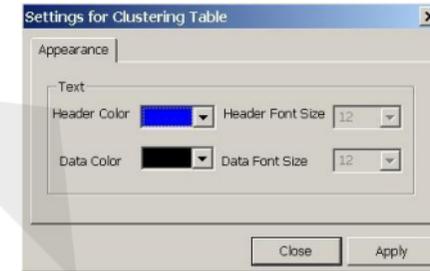


Figure 6.17: Change Text Format for Cluster Tables.

6.8 Statistics (Grading) Analysis Setup and Operation (Optional)

The purpose of Statistics is to automatically calculate statistic properties such as average, standard deviation and histogram for a selected B- or C-Scan data. This is a much improved version of the Bond Analysis Software option which was in the ULTRAWIN Software. It adds multiple grade levels (up to 16) and valuable statistical information of a selected screen area or full screen.

Region	Left	Top	Width	Height			
	1.000	0.500	1.000	1.000			
Cluster#	Location		Amplitude			Size(In*In)	
	X(In)	Y(In)	THK(In)	Min(%)	Max(%)	Ave.(%)	
#1	1.601	0.509	0.380	9.4	47.2	22.7	0.028(2.7)
#2	1.191	0.880	0.385	9.4	28.5	16.4	0.009(0.9)
#3	1.190	0.595	0.384	6.8	29.4	17.2	0.006(0.6)
#4	1.965	0.570	0.367	42.6	52.8	49.3	0.004(0.4)
#5	1.680	0.570	0.367	36.6	46.0	44.0	0.003(0.3)
#6	1.405	0.588	0.366	42.1	50.6	45.8	0.002(0.2)
#7	1.325	0.590	0.367	39.6	45.1	42.3	0.001(0.1)

CA1=0.060(5.9%); CA2=0.028(2.7%); F1=94.1%; F2=97.3%

Figure 6.16: Example of Cluster Analysis: Table View.

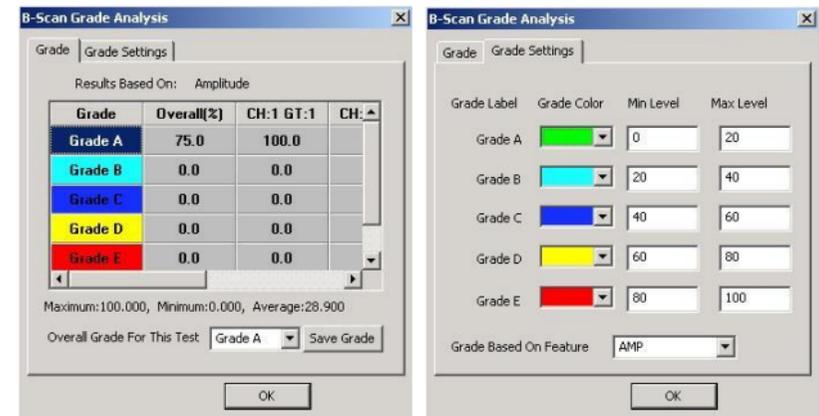


Figure 6.18: B-Scan Statistics (Grade) Analysis Setup Dialogs.

6.8.1 Statistics (Grade) Analysis For B-Scan Data

For B-Scan data, the gate features are recorded as a 1-D array. With grade analysis, the minimum, maximum, average, and histogram for the data are calculated and displayed in a tabular form, allowing a quantitative assessment of the B-Scan data. The grade analysis can be turned on and configured from the Analysis menu or the ‘Statistics Analysis’ tool button.

As shown in Figure 6.18, the B-Scan Grade Analysis dialog includes two pages. The first page shows the analysis results. The histogram is listed in a table. The first column in the table lists the colored grade label. The second column displays the overall percentage of each grade. The overall results are calculated based on data for all channels and gates. In the subsequent columns, the percentage of each grade for each enabled channel and gate are listed. At the bottom of the table, the maximum, minimum and average of all data are displayed. Based on the overall histogram results, the program will automatically determine the Overall Grade for this data set. You can manually change the overall grade from the drop-down list box. Click the “Save Grade” button to save the results in a file with ASCII format. You can open the file with any text edit program.

In the second page, as shown in the bottom of Figure 6.18, you can change the label color, minimum and maximum levels for each grade. Using the drop-down list box to select the feature (AMP, TOF, TOF2-TOF1, AMP1/AMP2) for analysis. Once you switch back to the first ‘Grade’ page, the results will be automatically updated based on the new settings.

6.8.2 Statistics Analysis For C-Scan Data

For C-Scan data, the gate features are recorded as a 2-D array, you can perform statistics analysis for the whole data set or for the data selected by a rectangle. The statistic results are drawn on a color-graded histogram graph or displayed in a tabular form, allowing a quantitative assessment of the C-Scan data. The statistics analysis can be turned on and configured from the Analysis menu or the ‘Statistics Analysis’ tool button. The steps in setting up and running a statistics application are defined below.

Step 1. Set up your C-Scan Image graph and configure it to make sure it meets your requirements.

Step 2. Next we must configure the statistics function. The statistics setup dialog includes two pages as shown in Figure 6.19. This includes setup of the feature, threshold and display options. Each of these is described further below.

Analysis Feature: Feature name of the data for analysis. This feature name together with channel and gate index are determined by the C-Scan Image setting (Step 1). If you want to change the data source for cluster analysis, you need to close the setup dialog and go back to Step 1 to setup the image with the data source you want.

Threshold Value: Up to 16 thresholds can be used. Using the ‘Num. of Threshold’ edit box to change the number of thresholds. The thresholds are indicated by red rectangles in the threshold graph. Drag the red rectangle to change the threshold values. The scale of the threshold graph is identical with the palette scale in the C-Scan Image graph. Check the ‘Auto Threshold based on Scale of Current image’ to make a uniform distribution of threshold.

Analysis Region: Select ‘Whole C-Scan Data’ to perform statistics analysis for the whole image. Select ‘Selected C-Scan Data’ to perform statistics analysis for the region indicated by a rectangle or an oval in the C-Scan graph as shown in Figure 6.19.

Step 3. Now we are ready to run a test by clicking the ‘Update Statistics’ button. When the ‘Update Statistics’ button is clicked, statistic results of the selected C-Scan data are calculated.

The ‘Display’ page provides tools to view the statistic results

Click ‘Add Statistics Table’ to bring up a table view with the tabulated statistic results as shown in Figure 6.20. The table shows statistic results including: maximum, minimum, average, standard deviation and histogram. The first section of the table shows the overall statistic results of the data:

Max: maximum value of the data in the selected region.

Min: minimum value of the data in the selected region.

Average: average value of the data in the selected region.

Std: standard deviation of the data in the selected region.

The second section of the table shows the distribution (percentage) of the data within each threshold region.

Inside the table, right click the mouse will bring up a popup menu. Select the ‘Table Setup’ menu item to configure the table.

When the ‘Save’ button at the bottom of the table is clicked, a file saving dialog will be displayed and input the file name to save the results. The statistics table is saved in an ASCII format.

Click ‘Add Statistics Graph’ to bring up a histogram graph as shown in Figure 6.21. The graph plot the statistic distributions with a bar display.

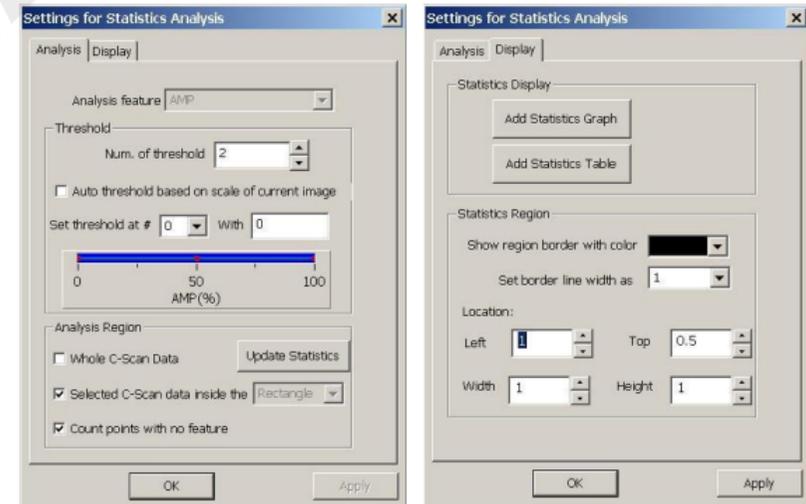


Figure 6.19: Statistics Analysis Setup Dialogs.

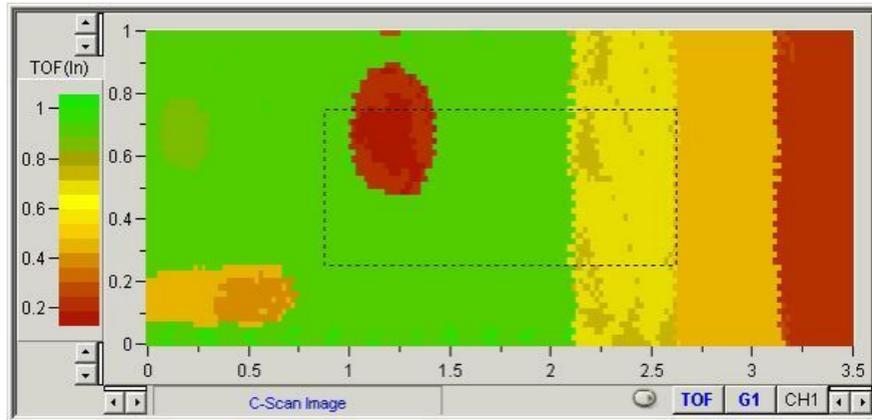


Figure 6.20: Example of C-Scan Image Graph with a Statistics Analysis Rectangle.

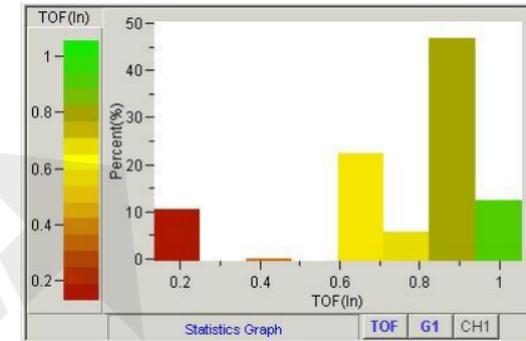


Figure 6.22: Graphic View of Statistics Analysis Results.

	Total Acq#	Total Area	Missing Acq#	Missing Area
Statistics	4489	1.010	12	0.003
	Max (%)	Min (%)	Average (%)	Std. (%)
	94.893	2.976	42.098	19.521
Distribution	Thresh. (%)	Percent(%)	Thresh. (%)	Percent(%)
	0.000 - 12.500	2.3	12.500 - 25.000	19.8
	25.000 - 37.500	23.4	37.500 - 50.000	24.6
	50.000 - 62.500	15.0	62.500 - 75.000	6.4
	75.000 - 87.500	5.3	87.500 - 100.000	2.8

Figure 6.21: Tabulated View of Statistics Analysis Results.

6.9 Image Analysis Setup and Operation

UTwin provides image analysis tools to quickly extract many image features for any selected regions and image processing tools to rotate and smooth C-scan images. Image analysis can be activated on any C-Scan image. It can be turned on and configured from the Analysis menu or the 'Image Analysis' tool button. The setup dialog for image analysis includes two pages as shown in Figure 6.23.

In the Feature Analysis page, you can select the image features that you want to be calculated and be displayed on the graph. These image features include: 'A': Area; 'AV': Average; 'MI': Minimum; 'MA': Maximum; 'P': Percent of pixels with value within the given thresholds, which is equivalent to CA1 or F1 value in cluster analysis. 'D': Percent of defects. A cluster of connected pixels is called a defect if their value is within a given threshold and their total size is above the defect threshold. This parameter is equivalent to CA2 or F2 value in cluster analysis. To calculate 'P' and 'D', you need to specify thresholds. You can revise these thresholds using the edit boxes given in the 'Threshold for Calculation' group. The upper and lower thresholds are inputted as percentage related to the palette scale. For example, if the minimum and maximum value of the palette is 1 and 2, then 0% means 1 and 50% means 1.5 and 100% presents 2. The unit of the defect threshold is area which can be Inch*Inch or mm*mm. Unlike the statistic and cluster analyses, these image analysis parameters are calculated based on the image color level instead of C-scan data. Thus these parameters will depend on your palette scale settings and the value could be different with these values calculated by cluster and statistics analyses (in most cases, the difference is very small and negligible). Check 'Show Remain Area' box if you want to display the percentage of the remain area (pixels with value outside the thresholds). Click the "Show Drawing" Toolbar button to bring up the floating drawing toolbar, which is the same as the annotation toolbar. Then you can draw rectangles, ovals or polygons on the images and press Update Results (or hot key CNTRL+S) to perform analysis for these selected regions. Figure 6.24 shows an example of C-scan image with these parameters.

In the Filter and Rotation page, there are several image processing tools. In the Filter group, click the 'Fill all missing points (white or black) with nearest data' button to fill these points without valid data due to loss of gate synchronization or data amplitude below threshold. Figure 6.25 shows an example of a C-scan graph after the missing data have been filled with nearest data. The original graph is shown in Figure 6.24. Click 'Smooth image based on the filter' button, to smooth the selected image. Figure 6.26 shows an example of a C-scan graph after smoothing with Gaussian filter.

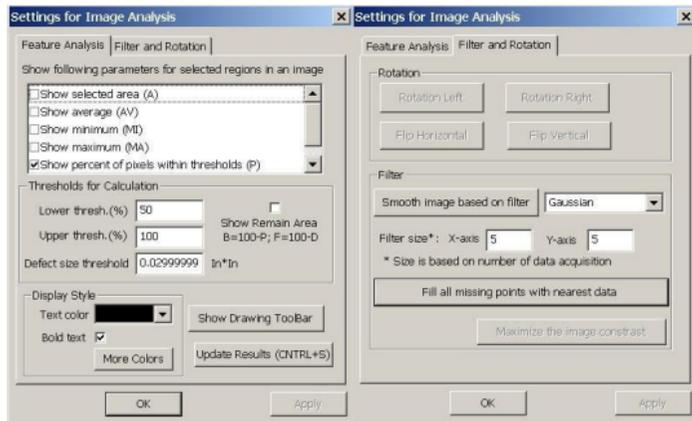


Figure 6.23: Image analysis setup dialog.

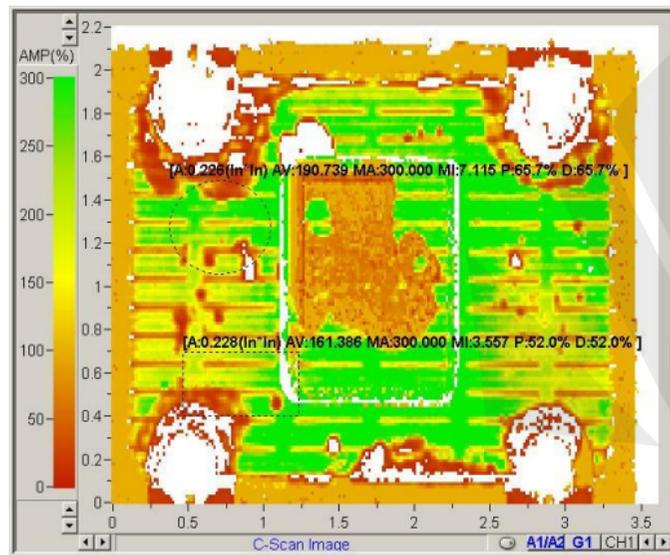


Figure 6.24: An example of a C-scan graph with image analysis parameters.

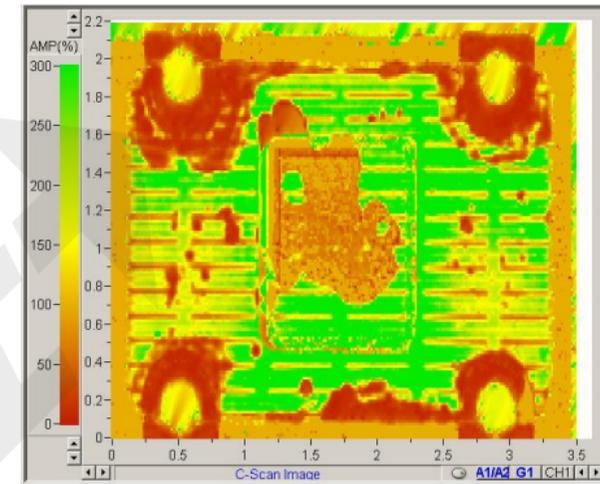


Figure 6.25: An example of a C-scan graph after the missing data have been filled with nearest data. The original graph is shown in Figure 6.24.

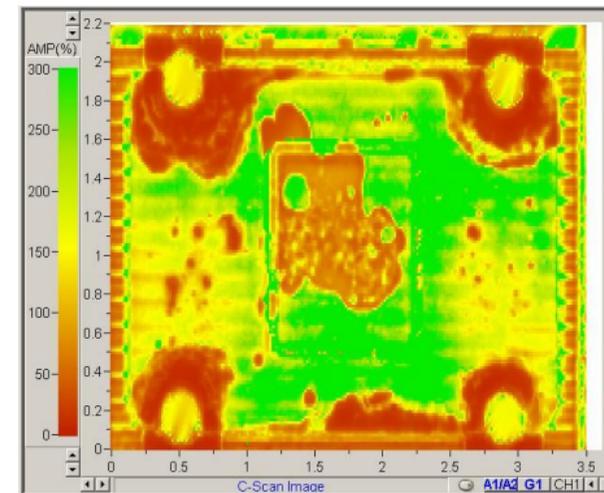


Figure 6.26: An example of a C-scan graph after smoothing with Gaussian filter. The original graph is shown in Figure 6.25.

6.10 Flaw Analysis (Optional)

UTwin provides flaw analysis to process C-scan data based on users' defined flaw criteria and gives test fail or pass result. This analysis can be automatically started after real-time data acquisition and give operator test pass/fail result immediately after testing.

To setup flaw analysis, open the 'Flaw Analysis' dialog from the Analysis menu. At the top of the dialog, there are a group of edit boxes including following parameters:

- Min Wall THK(In):** Allowed minimum thickness.
- Missed THK Limit(In*In):** That is the maximum allowed area which does not have valid data. If invalid data area is above this area, test fail flag will be indicated.
- Specification:** You may input the specification name on which the flaw analysis is based.
- Min Wall Based on:** You can select minimum or average. Due to noise, some time averaging gives more reasonable value regarding the minimum thickness.

At the bottom of the Flaw Setup dialog, there is a list table for flaw definition. The settings for each flaw type are similar to the cluster analysis settings. Actually the program uses the same clustering algorithm to find flaws for each flaw type. For each flaw type, you need to specify channel, gate, feature (Amplitude or thickness), lower threshold, upper threshold, size (minimum allowed size), Enabled, Start and End positions. The program only performs flaw analysis for these enabled flaw types. The Start and End positions define the flaw analysis range along the index axis. If the start position is set to the same value as the end position, then whole range will be analyzed. In current versions, whole range along the scanning axis is always analyzed. The same as cluster analysis, you can define flaw neighborhood which specify the separation of pixels within a flaw. If the nearest distance between two flaws is less than flaw neighborhood, then the two flaws are considered to be one flaw. Click the 'Test Fail and Pass Criteria' button to open the 'Inspection Fail and Pass Criteria' dialog as shown in Figure 6.28. Once flaws have been found, these criteria are applied to determine the test result (pass or fail). So far three criteria have been implemented:

- Test fails if defects have been detected in any of the checked flaw type. You can check these flaw types in the list box.
- Defects have been detected both in flaw type # and flaw type ##. In this case, test fails only when flaws found in both flaw type # and flaw type ## and the distance between the center point of the two flaws is less than the specified distance. This criterion is useful for multi-channel systems and more than one channels can detect the same flaw. Thus use this criteria can reduce false call.
- Defects have been detected both in flaw type # and flaw type ##. This criteria is the same as b) and provide an addition combination of flaws found in different channels and gates.

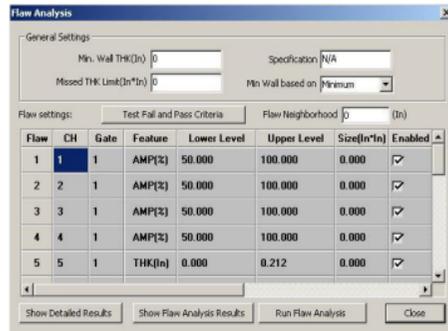


Figure 6.27: Flaw setup.

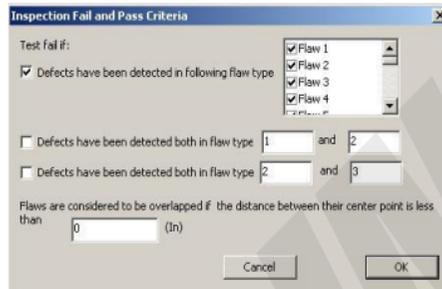


Figure 6.28: Inspection fail or pass criteria.

After you have setup the flaw analysis, you may save the project. The settings are saved in the project file and once you load the project, the flaw analysis parameters are automatically loaded. Click the 'Run Flaw Analysis' button in Figure 6.27 to perform flaw analysis for current C-scan data. Once analyzing has been done, you can click the 'Show Flaw Analysis Results' to view the results as shown in Figure 6.29. At the top of this Inspection Results dialog, some inspection information such as inspector, customer et al are listed and the overall analysis results such as minimum and average thickness and miss area are displayed. At the bottom of this dialog, results for each flaw type are listed. If flaws are found, in the Results column, the number of detected flaw is indicated and the text color becomes red. You can click this number to bring up a dialog shown in Figure 6.30 to view detailed information (location, size et al.) about each flaw. If you want to start flaw analysis automatically after a C-scan testing, check the 'Automatically run flaw analysis after each test' in the Inspection Procedure dialog (Figure 3.20).

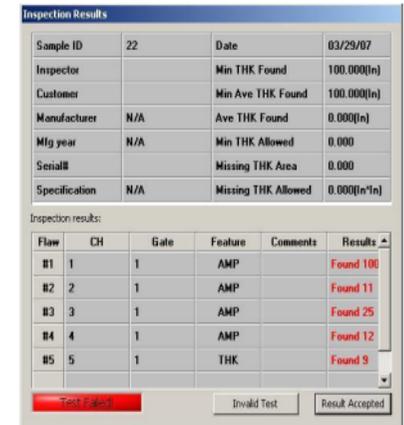


Figure 6.29: Flaw analysis results.

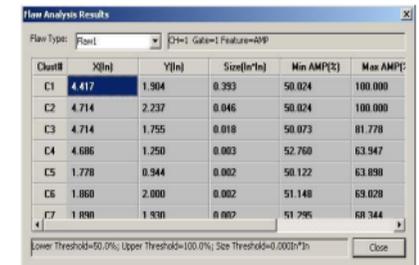


Figure 6.30: Flaw Analysis results.

6.11 Rf Replay (Optional)

RF waveform files (*.CSC files) collected in C-Scan mode contain a waveform for each and every UT sample collected (or pixel as displayed on the C-Scan screen). These data files can be replayed as standard with C-Scan or utilizing RF Waveforms for replay. Once the RF waveforms are replayed in C-Scan, the user can view the A-Scan presentation of any pixel in the C-Scan presentation (by using the cursor) or perform a new C-Scan replay with changed gate parameters. Details are presented below:

To Replay Waveforms in C-Scan and view individual A-Scans, the user would do the following:

1. In UTwin software, in replay mode, select the .CSC file to open.
2. If waveforms are stored in the data file that is being replayed, the C-Scan will be replayed by accessing the waveforms against the stored settings of the Gates, triggers, etc. The waveforms will also be queued up and waiting for further interaction.
3. Once the C-Scan is replayed, the user can now use the mouse and cursor to scan around the C-Scan and view the A-Scans of desired areas.
4. To use the mouse to review waveforms on the C-Scan screen, first create an A-Scan Graph. Then activate the cursor from the main toolbar. Now you will be able to move the cursor around on the C-Scan screen. You will see that the A-Scan will instantly change to the waveform stored for that exact pixel as you move the mouse.
5. When in this mode, individual A-Scan RF waveforms can be saved to a separate file by clicking the Save button at the bottom of the graph.

To Replay C-Scans using RF waveform replay using different gate, feature and trigger strategies, do the following:

1. Perform steps 1 – 4 above to replay the C-Scan.

Select “Replay Gates” button. A ‘Gate Settings for Rf Replay’ will be activated as shown in Figure 6.31. Anything in the Gates dialog can be changed. This includes changing from Sync mode to Threshold mode, Detection mode (Peak or Threshold), Gate start, Gate width and features to display. This can be done in conjunction with an A-Scan by moving the cursor to a desired location and setting the gates, etc.

2. Once these changes are made, a new C-Scan can be replayed from the stored waveform data by clicking the ‘Update B/C Scan Data’ button or the ‘Go’ button in the replay toolbar.
3. Upon selecting “Go” a new C-Scan will be replayed as if data was being collected from an actual part.
4. The user can interactively change gate settings, features to display and re-run the C-Scan as many times as necessary to achieve the desired result.
5. In addition, the user can save any one of the newly processed C-Scans to a *.CSC data file simply by clicking the ‘Save’ button and entry of a *.CSC file name. When a processed C-Scan is saved, it will be saved with the new setup information and the new feature data. The waveforms will not be saved with this new *.CSC file. Waveforms will only remain in the original RF Waveform stored file. Therefore the new *.CSC file will be identical to a C-Scan file without RF waveform saving.

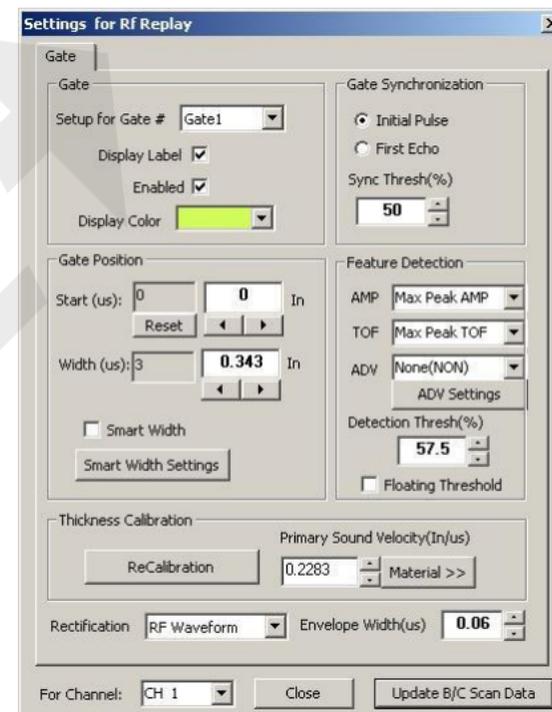


Figure 6.31: Gate Settings for Rf Replay.

6.12 Image Container

UTwin includes an Image Container Graph which can display images from different data files. With this graph, you can compare data from these different data files on the same graph.

6.12.1 B-Scan Image Container

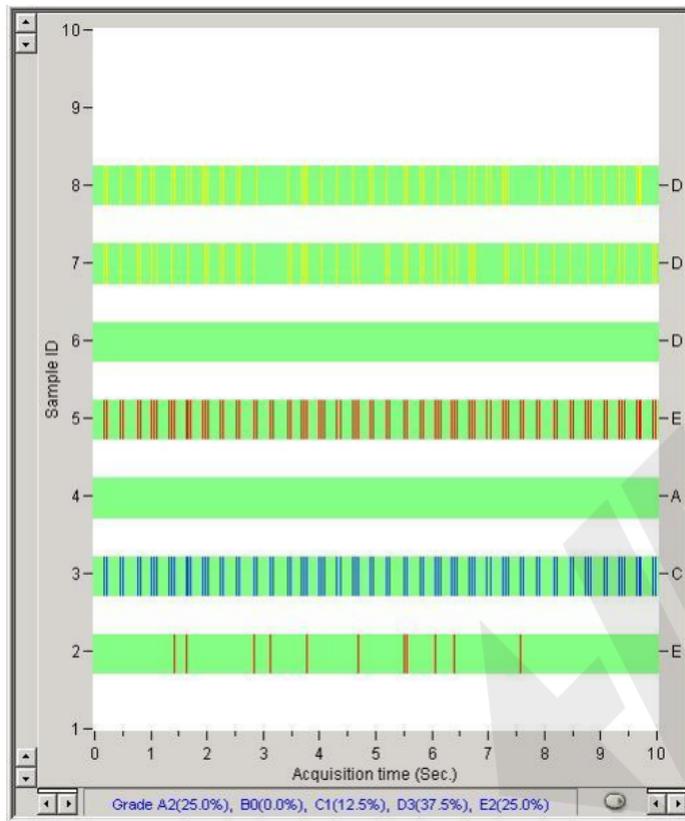


Figure 6.32: B-Scan Image Container Graph.

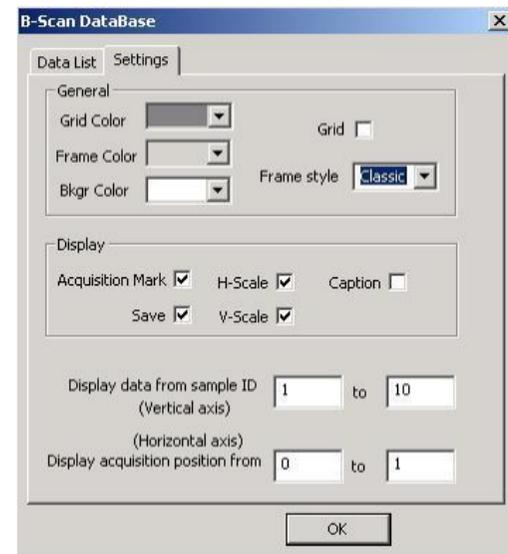
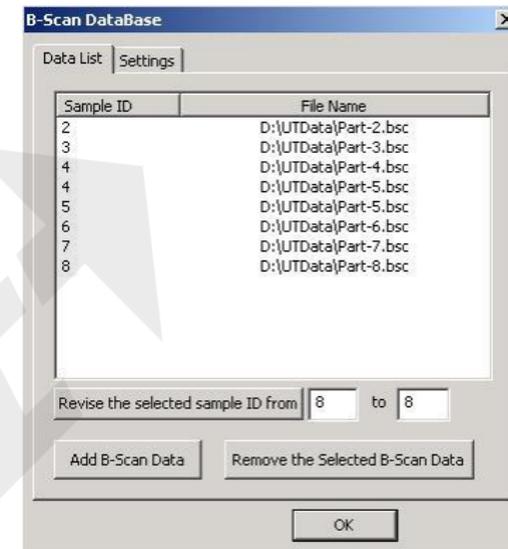


Figure 6.33: B-Scan Container Graph Setting

An example of the B-Scan Image Container Graph is shown in Figure 6.32. In this graph, the horizontal axis is the acquisition axis, the left vertical axis is the sample ID and the right vertical axis is the overall grade for the corresponding sample ID. The B-Scan data for each sample ID is displayed as a colored horizontal bar. The pixel color at a given acquisition time is the grade color calculated based on the maximum value among all channels and gates at that acquisition time (or position). At the bottom of the graph, the number of samples in each grade is displayed. For example, Grade A2(25.0%) presents 2 sample in grade A, which counts for 25% of all samples. You can use the spin buttons to change the X and Y axis scales.

To setup the graph or add more data, simply double click the graph or select “Graph Setup” from the menu. Figure 6.33 shows the setup dialog for the B-Scan Image Container Graph. In the first ‘Data List’ page, use the ‘Add B-Scan Data’ and ‘Remove the Selected B-Scan Data’ buttons to add or remove data. The list box lists all data you have added. You can revise the sample ID if it is not correct. In the second ‘Settings’ page, you can change the appearance of the graph such as colors. If the ‘Acquisition Mark’ is checked, the time mark recorded during acquisition will be displayed (only the time mark of the first B-Scan data file will be displayed). You can manually change the sample ID range (vertical scale) for viewing and zoom the horizontal axis.

7. OPTIONS FOR UTwin

7.1 Supervisor Option

The ‘Supervisor Option’ allows the user to restrict access to the software by the use of a password. With this option installed, the software will start up in supervisor mode by default. The Supervisor option in UTwin is implemented based on the User Manager menu as discussed in section 3.3.1.9. So far only one user account information is saved. If you are a supervisor, you may want to setup your user name and password in the user manager dialog. In the user manager dialog, you can check these settings which you don’t want other users to change without your password. If there is a valid password, then other users cannot open the user manager dialog without the password, thus they can not change your user interface settings without your permission.

How to set the password: The first time the user tries to open the user manager dialog, no password is needed. Then you can input your user name and password which must be 4-8 alphanumeric characters in length. It is case sensitive. From this point on, the user must enter this password to open the user manager dialog.

How to change the password: The user can change the password by opening the user manager dialog.

What to do if you forget the password: If you forget the password the only way to recover is to uninstall the software and reinstall it. This will allow you to enter a new password.

7.2 Chain Scan Option

With chain scan control, users can set up multiple “sequential” scans and change the current scan they are viewing, if the chain scan option has been enabled. There will be one list box and a chain scan control button shown on the main toolbar as indicated in Figure 7.1. The list box contains all the scanning sequences. Click the ‘Chain Scan Control’ button to bring up the Chain Scan Setup Dialog. With the Chain Scan Control dialog (see Fig. 7.2), you can set up their scanning sequences. The following functions exist for operating the Chain Scan option:

- ‘Chain Scan Setup’ dialog contains a set of commands that enables the user to manipulate the Chain Scan:
- ‘Add’ button for adding a new sequence at the end of the sequence list. You can change the sequence name using the ‘Chain Scan Name’ edit box. The maximum number of sequences currently is five for standard UTwin.
- ‘Del’ button for removing the select sequence from the list.
- ‘Up’ button for moving up a sequence. This command is used to swap the current selected sequence and the immediate above sequence.
- ‘Down’ button for moving a sequence down. This command is used to swap the current selected sequence with the next immediate sequence.
- The ‘Motion Seq.’ button is used to configure the motion sequence for each axis when starting a C-Scan. Click this button to bring up the Motion Sequence Configuration Dialog (Figure 7.3). In this dialog, you can edit the sequence number for each axis. Axes with a lower index move first. Axes with the same index will move at the same time.
- Check the ‘Enable Automatic Chainscan’ box to enable automatic chain scan mode. In automatic chain scan mode, the C-Scan will start with the 1st sequence, then carry out the 2nd sequence, 3rd sequence, and so on without user’s intervention up to the “maximum” number of sequences programmed.

During the A-Scan setup, users can view and change the setups for each and every sequence by first selecting it from the dropdown list in the main toolbar. If the automatic chain scan is enabled, then when C-Scan is started, all sequences will be executed one after another, without your intervention. C-Scan data is automatically saved in the specified data folder of your project after each scan. The data file name is automatically generated using the chain scan name plus sample ID. During replay, you can open them one by one or all together using the batch file process function. If the automatic chain scan is disabled, you can manually select any sequence from the list and just execute the selected sequence.



Figure 7.1: Chain Scan Control Dialog.

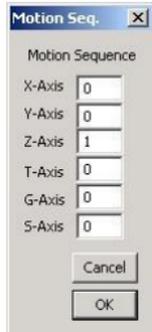


Figure 7.3: Motion Sequence Configuration Dialog.



Figure 7.2: Chain Scan Setup

7.3 Complex Contour Following (CCF) Option

7.3.1 CCF Capabilities and Principals

Using the CCF option, ultrasonic C-scans for inspection of complicated surface profiles can be performed. The surface contour is generated by interpolation with a set of trained points. A trajectory motion control algorithm is used to move the transducer along the trained contour and keep the transducer normal to the sample surface during scanning. The surface contour and C-scan results are displayed in 2D and 3D. To perform CCF test, a PCI-SMCS board with a motorized manipulator is required.

Carrying out a complex-contour-following C-scan requires three steps: calibrating the scanner coordinate system; training the contoured surface; then performing C-scan and replay.

To access the Contour Following Inspection mode, in the Main menu, select

Configure Inspection Mode Contour Following

After you have selected the Contour Following inspection mode, the A-scan graph, complex-contour setup dialog, 3D-contour view graph and scanner jog window will be automatically aligned as shown in Figure 7.4.

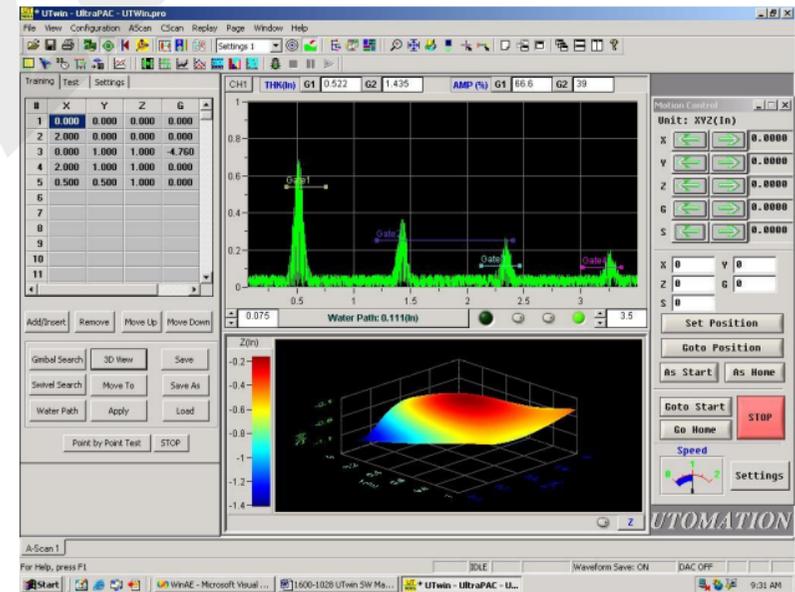


Figure 7.4: Recommended Standard Screen Layout in the Contour Following Training Mode.

7.3.2 Scanner Coordinate System Calibration

For mathematical description of the sample contour and the spatial relation between the sample and scanner, a predefined absolute coordinate system (see Figure 7.5) is specified for the scanning system. Figure 7.5 shows the positive direction for each scan axis. The axis for the rotation table should overlap with the z axis. If the scale or positive direction is different with the requirement (Figure 7.5), using the scanner configuration for adjustment. These setup parameters are usually fixed for a given bridge or scanner. The center point of the reference sample is the origin (zero) of the coordinate system. The spatial relation between the testing and the calibration samples should be the same during training and testing.

Note: the calibration for the scanner (scale and positive direction) only needs to be performed once. However, each time the sample is moved, one needs to recalibrate the origin of the system. One can use any convenient sample to perform these calibrations.

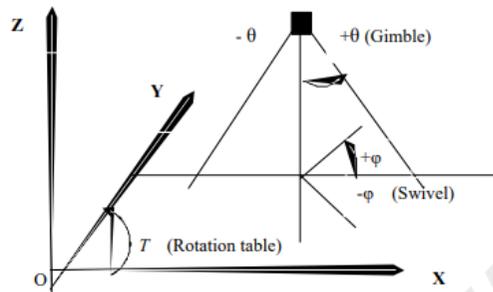


Figure 7.5: Definition of the Scanner Coordinate System (X, Y, Z, T, θ , ϕ)

7.3.3 Contour Training

The diagram of the training procedure is given in Figure 7.6. Figure 7.7 shows the three dialogs for contour training, testing and parameter settings.

In the 'Settings' dialog, you need to setup the necessary parameters for the training operation. In this dialog, the following parameters are inputted:

Sensor Length (Training): the distance between the center point of the motorized manipulator and the center point of the front surface of the transducer used during training.

Water Path (Training): the distance between the center of the front surface of the transducer to the point of the part front surface which the transducer is normal and focused on the surface (This value will be used in automatic water path search).

Active Axis: only these selected axes will be used in training and scanning.

Symmetrical Axis: the symmetrical axis is the axis along which all other axes (index axes) don't change. If "No" is selected, complex contour following will be used; otherwise symmetrical contour following will be applied.

Scanning Plane: select XY plane for nearly flat samples and ZT plane when turntable is used

Gimble Search Range: these values are used in Gimble search.

Swivel Search Range: these values are used in Swivel search.

Water Path Search Range: maximum search distance in water path search.

Protection: when selected, the transducer will be lifted to the selected Z-axis clearance height before moving in x and y direction to prevent crashing of the sensor with the sample.

Z-axis clearance height: give the height at which the scanner can move in x and y axes without crashing into the sample.

Maximum G-axis position: maximum gimble position.

The 'Training' dialog shown in Figure 7.7(a) includes a table, which lists the coordinates of all training points and several buttons for the training operation

Add/Insert: add a new training position. The initial coordinate of the new training position will be automatically generated based on previous training position.

Remove: remove the current training position from the list of trained positions.

Move Up: move the selected point up by one row in the list.

Move Down: move the selected point down by one row in the list.

Gimble Search: the gimble axis will scan a defined range from the current position to find the angle with peak reflection.

Swivel Search: the swivel axis will scan a defined range from its current position to find the angle with peak reflection.

Water Path: the distance between the transducer and sample surface will be adjusted along the current normal direction to obtain the given time-of-flight.

3D View: when more than four training positions have been programmed, you can click this button to view or update the 3D interpolated surface.

MoveTO: moves the scanner (six axes) to the current training position.

Apply: accept the scanner position for the current training position and save the sensor coordinate associated with this point in memory. These values will be used for smooth surface fitting.

Save: save the trained coordinates and settings to the current default file.

Save as: save the trained coordinates and settings with a different filename.

Load: load the trained coordinates from a saved file.

Point by Point Test: this is a special testing mode when only the feature (thickness) at the trained positions are needed. Click this button to start the test and click the 'STOP' button to stop the test.

JOG Pendant training

The following is the relation between the JOG Pendant Key and Training Operation Interface

JOG PENDANT	User Interface
F1	Gimble Search
F2	Swivel Search
F3	Water Path
SHIFT+F3	Add/Insert
CTRL+F2	Remove
ENTER	Apply

Note: for safety, always first training at the highest position.

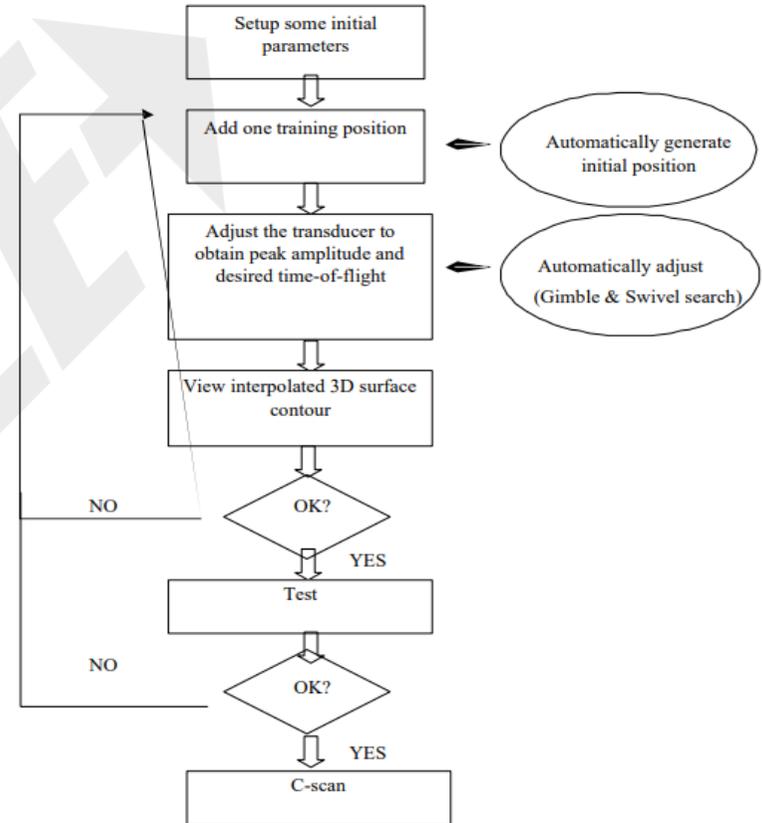


Figure 7.6: Diagram of Training Procedure.

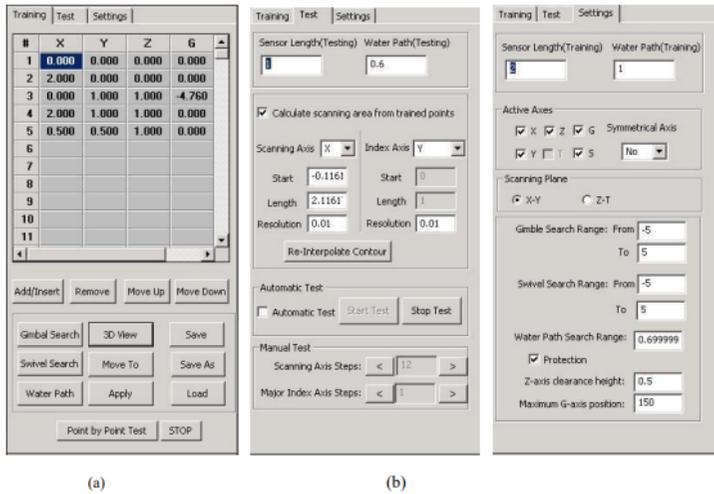


Figure 7.7: Complex Contour Setup Dialog: (a) Training, (b) Testing, (c) Parameter Settings.

7.3.4 Contour Testing

The ‘Testing’ dialog shown in Figure 7.7(b) is used to run a quick verification of the trained contour. During test, the A-scan window is on and the signal is updated during scanning. Inspectors can check the quality of the trained contour surface by observing the change of the surface reflection signal in the A-scan window.

- Sensor Length (Testing):** the sensor length during testing or C-scan.
- Water Path (Testing):** the required water path length in testing.
- Scanning axis:** automatically selected by the program.
- Major index axis:** automatically selected by the program.

Input **Start** position, **Length** of Scanning and **Resolution** for these two axes. If the ‘Calculate scanning area from trained points’ check box is enabled, these values are calculated from the trained points to make the test region cover all trained region.

Check the ‘Automatic Test’ check box to perform automatic test. In automatic test mode, the ‘Start Test’ button is enabled. Click this button to start the test. If automatic testing is selected, it will run a scan similar to C-scan but with the A-scan window ON. Usually, the gate should be set to the top surface reflection during testing. Thus the more uniform the TOF and AMP distribution, the better the trained surface. If manual testing is selected, you can use the four arrow buttons (> and <) to move from one acquisition point to another acquisition point. The A-scan window will be updated in real-time. If at an acquisition point, the A-scan signal is not as expected (amplitude is too low or TOF is changed), you can go back to the ‘Training’ dialog and add additional training at that position.

Tips: one can always first train several points at irregular positions and then train points at regular positions determined by the manual testing.

7.3.5 Contour Following C-Scan

The procedure to perform a contour following C-Scan is identical with those for a standard C-Scan as described in Section 5. In contour following C-Scan mode, you can setup speed for all axes as shown in the bottom of Figure 7.8.

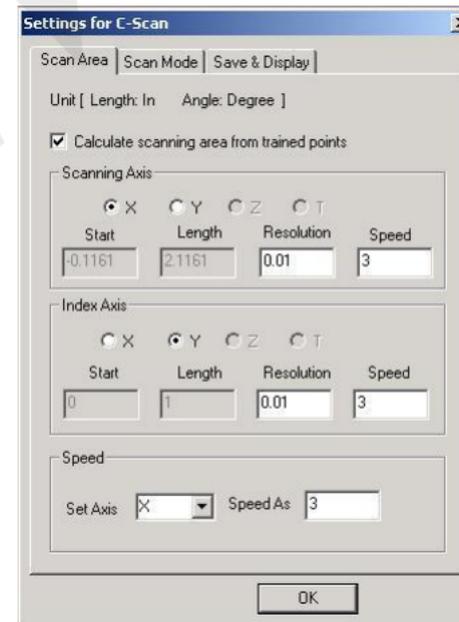


Figure 7.8: Setup Parameters for Contour Following C-Scan.

7.3.6 Contour Following Replay

The procedure to replay a data file acquired with contour following is identical with that for replaying a standard C-scan data file as described in Section 5.

7.4 Auto Report Option

UTwin includes a powerful auto-reporting function. With the Auto Report option, any data (A-Scan waveform, B-Scan data, C-Scan data, tables etc.) and any graph images can be exported directly into Microsoft Excel and Word. This function makes it very easy for you to document and evaluate data and prepare a test report.

If this option is installed, two submenu items ‘To Excel’ and ‘To Word’ will appear in the ‘Analysis’ main menu.

In addition, two corresponding tool buttons   will be shown in the main toolbar.

7.4.1 Data/Graph to Microsoft Excel

To export data/graph, first select the graph (clicking it), then select ‘To Excel’ to activate the ‘To Excel’ dialog. Different graphs/data have different ‘To Excel’ dialogs.

Figure 7.9 shows the A-Scan to Excel dialog. At the left top of this dialog, there is a group of radio buttons called ‘Export to Excel’. Select the item you want to export. Three types of items can be exported:

Image of this page: bitmap of the whole page.

Image of this graph: bitmap of the graph.

Waveform data: text-formatted data.

In addition, you can also select ‘Export hardware settings’ and ‘Gate feature’. These parameters will be exported in a separated Excel sheet.

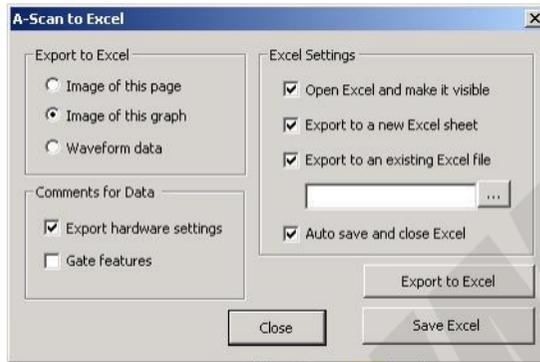


Figure 7.9: A-Scan to Excel Configuration Dialog.

In the ‘Excel Settings’ group, there are several options:

Open Excel and make it visible: check this box to make the Excel program visible.

Export to a new Excel sheet: if checked, the data/graph will be exported in a new data sheet each time you click ‘Export to Excel’.

Export to an existing Excel file: if checked, the data/graph will be exported in the existing Excel file.

Auto save and close Excel: if checked, Excel will be automatically closed when closing this dialog.

Click the ‘Export to Excel’ button to start exporting. A dialog, which indicates the exporting progress, will appear. Click ‘Save Excel’ button to save the Excel spread sheet in a file. Figure 7.10 shows an example of exported hardware settings and Figure 7.11 shows the exported waveform data in an Excel spread sheet. The first column is acquisition time and the second column is waveform amplitude.

For Spectrum Graph, Selecting ‘To Excel’ will activate the ‘Spectrum to Excel’ dialog, which is identical with the ‘A-Scan to Excel’ except that the Waveform data will be replaced by Spectrum data.

	A	B	C	D	E
1					
2	Test Setup Information				
3	Operator:				
4	Date:	4/10/2006			
5	Job Name:	UTwin			
6	Part Name:	Part			
7	Comment:				
8					
9	A/D Setup Channel:1				
10	Delay(us):	3.195			
11	Width(us):	20.289			
12	Gain(dB):	60			
13	Offset(mV):	0			
14	Sampling Rate Sel:	3			
15	Average:	1			
16	Trig Source Sel:	0			
17	Filter Mode:	On			
18	LP Filter Sel:	0			
19	HP Filter Sel:	0			
20	DAC:	Off			
21	AGC:	Off			
22					
23	P/R Setup Channel:1				
24	P/R Voltage Sel:	0			
25	P/R Damp Sel:	0			
26	P/R Energy Sel:	0			
27	P/R frequency(MHz):	5			
28	P/R Gain(dB):	0			
29	P/R Filter Mode:	Off			
30					
31	Gate Settings				
32		Gate1	Gate2	Gate3	Gate4
33	Gate Status:	On	On	On	On
34	Synchronization Mode:	Initial Pulse	Initial Pulse	Initial Pulse	Initial Pulse

Figure 7.10: Example of Exported Hardware Settings.

	A	B	C
1	Scan Waveform		
2	Time(us)	Amplitude	
3	3.195	0.007	
4	3.295	0.029	
5	3.395	0.037	
6	3.495	0.027	
7	3.595	0.017	
8	3.695	-0.007	
9	3.795	0.023	
10	3.895	0.001	
11	3.995	-0.008	
12	4.095	0.016	
13	4.195	-0.046	
14	4.295	-0.007	
15	4.395	0.023	
16	4.495	-0.027	
17	4.595	-0.004	
18	4.695	-0.033	
19	4.795	0.004	
20	4.895	0.010	
21	4.995	0.000	
22	5.095	-0.023	
23	5.195	-0.025	
24	5.295	-0.035	
25	5.395	0.005	
26	5.495	0.014	
27	5.595	-0.021	
28	5.695	0.027	
29	5.795	-0.008	

Figure 7.11: Example of Exported Waveform Data

For Feature Monitoring and B-Scan graphs, selecting “To Excel” will activate the “B-Scan to Excel” dialog as shown in Figure 7.12. Most functions in this dialog are the same as those in the “A-Scan to Excel” dialog shown in Figure 7.9. Compression may be necessary because all current versions of Excel are limited to a total of 65536 rows. In the ‘Data Compression’ group, you can setup the compression parameters. The data can be compressed based on maximum, minimum and average.

Figure 7.13 shows an exported B-Scan data in Excel spreadsheet. The first column shows the acquisition position and subsequent column shows recorded gate features for all enabled channels and gates. The channel and gate numbers are indicated in the first row.

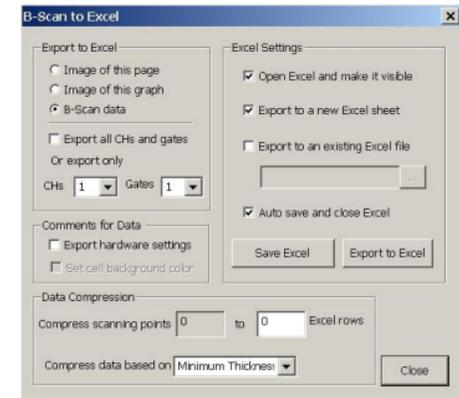


Figure 7.12: B-Scan to Excel Configuration Dialog.

1	A	B	C	D	E	F	G	H	I	J	K	L	M
		Gate=1 Ch=1 AMP	Gate=1 Ch=1 TOF	Gate=2 Ch=1 AMP	Gate=2 Ch=1 TOF	Gate=3 Ch=1 AMP	Gate=3 Ch=1 TOF						
2	0.000	11.184	0.290	100.000	0.052	100.000	0.085						
3	0.010	13.532	0.313	100.000	0.052	100.000	0.085						
4	0.020	11.136	0.313	100.000	0.052	100.000	0.085						
5	0.030	11.184	0.336	100.000	0.052	100.000	0.085						
6	0.040	12.063	0.324	100.000	0.052	100.000	0.085						
7	0.050	12.063	0.313	100.000	0.052	100.000	0.085						
8	0.060	12.555	0.336	100.000	0.052	100.000	0.085						
9	0.070	11.233	0.324	100.000	0.052	100.000	0.085						
10	0.080	12.308	0.313	100.000	0.052	100.000	0.085						
11	0.090	13.385	0.313	100.000	0.052	100.000	0.085						
12	0.100	10.842	0.324	100.000	0.052	100.000	0.085						
13	0.110	12.506	0.313	100.000	0.052	100.000	0.085						
14	0.120	12.308	0.324	100.000	0.052	100.000	0.085						
15	0.130	11.868	0.324	100.000	0.052	100.000	0.085						
16	0.140	12.604	0.336	100.000	0.052	100.000	0.085						
17	0.150	11.770	0.347	100.000	0.052	100.000	0.085						
18	0.160	12.015	0.313	100.000	0.052	100.000	0.085						
19	0.170	11.575	0.302	100.000	0.052	100.000	0.085						
20	0.180	10.598	0.313	100.000	0.052	100.000	0.085						
21	0.190	13.190	0.347	100.000	0.052	100.000	0.085						
22	0.200	11.331	0.302	100.000	0.052	100.000	0.085						
23	0.210	11.673	0.313	100.000	0.052	100.000	0.085						
24	0.220	10.745	0.290	100.000	0.052	100.000	0.085						
25	0.230	11.575	0.324	100.000	0.052	100.000	0.085						
26	0.240	11.233	0.324	100.000	0.052	100.000	0.085						
27	0.250	11.087	0.290	100.000	0.052	100.000	0.085						
28	0.260	11.038	0.336	100.000	0.052	100.000	0.085						

Figure 7.13: An Example of Exported B-Scan Data.

For C-Scan graph, select “To Excel” will activate the “C-Scan to Excel” dialog as shown in Figure 7.14. Most functions in this dialog are the same as those in the ‘B-Scan to Excel’ dialog shown in Figure 7.12. The C-Scan data is a 2-D array. The scan data is stored in the rows with each index “line” stored in a successive column. Current

versions of Excel are limited to a total of 255 columns and 65536 rows. Data compression for both scanning and index axes can be specified with maximum, minimum and average compression algorithm.

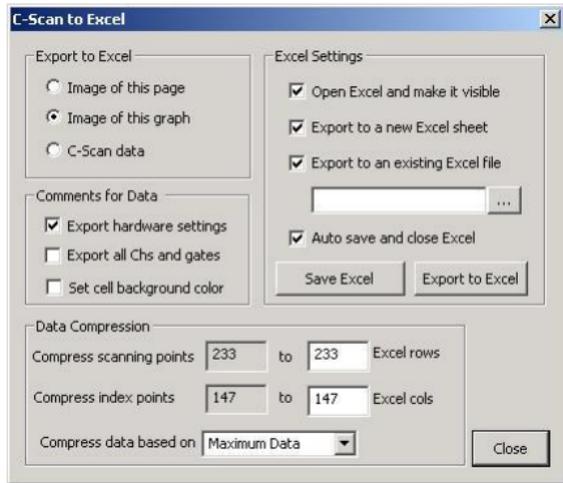


Figure 7.14: C-Scan to Excel Configuration Dialog.

Figure 7.15 shows an exported C-Scan data in Excel spreadsheet. The first column shows the scanning position and the first row shows the index position. The C-Scan data is displayed as a 2D array. If the check box 'Export all Chs and gates' has been enabled, C-Scan data in all enabled channels and gates will be exported onto a separate sheet simultaneously. The example shown in Figure 7.15 has no color background for each cell. If the check box 'Set cell background color' is enabled, both data and the corresponding color will be exported as shown in Figure 7.16. The color shown in the Excel is identical with that in the C-Scan graph.

Tables such as statistics and clustering tables can be directly exported to Excel. To export tables, select the table and then click 'To Excel'. There is no dialog to setup parameters. The table will automatically be exported. Figure 7.17 shows an exported statistics table.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1		0.0000	0.0200	0.0400	0.0600	0.0800	0.1000	0.1200	0.1400	0.1600	0.1800	0.2000	0.2200
2	0.000	0.926	0.926	0.941	0.926	0.441	0.441	0.441	0.448	0.448	0.448	0.448	0.926
3	0.020	0.926	0.941	0.926	0.926	0.441	0.433	0.441	0.441	0.448	0.448	0.448	0.926
4	0.040	0.941	0.941	0.941	0.941	0.441	0.433	0.441	0.441	0.448	0.448	0.448	0.941
5	0.060	0.941	0.946	0.941	0.941	0.441	0.441	0.441	0.441	0.448	0.448	0.448	0.941
6	0.080	0.946	0.946	0.941	0.941	0.441	0.433	0.441	0.441	0.448	0.448	0.448	0.941
7	0.100	0.946	0.938	0.946	0.941	0.441	0.433	0.441	0.441	0.441	0.445	0.445	0.437
8	0.120	0.946	0.934	0.946	0.946	0.441	0.433	0.433	0.441	0.445	0.445	0.445	0.437
9	0.140	0.926	0.926	0.934	0.941	0.437	0.430	0.437	0.437	0.445	0.437	0.445	0.437
10	0.160	0.926	0.926	0.926	0.941	0.437	0.430	0.437	0.437	0.445	0.445	0.445	0.445
11	0.180	0.926	0.941	0.926	0.926	0.437	0.430	0.437	0.437	0.445	0.445	0.445	0.445
12	0.200	0.941	0.941	0.926	0.941	0.437	0.430	0.437	0.445	0.445	0.445	0.445	0.445
13	0.220	0.941	0.941	0.941	0.941	0.437	0.430	0.437	0.445	0.445	0.445	0.445	0.445
14	0.240	0.941	0.946	0.941	0.437	0.437	0.430	0.445	0.437	0.445	0.445	0.445	0.445
15	0.260	0.941	0.946	0.946	0.437	0.437	0.430	0.445	0.437	0.445	0.445	0.445	0.445
16	0.280	0.946	0.946	0.946	0.437	0.437	0.430	0.437	0.437	0.445	0.445	0.445	0.441
17	0.300	0.946	0.946	0.946	0.437	0.437	0.430	0.437	0.437	0.437	0.433	0.445	0.433
18	0.320	0.946	0.946	0.946	0.437	0.437	0.430	0.437	0.445	0.437	0.433	0.433	0.433
19	0.340	0.946	0.941	0.946	0.433	0.437	0.425	0.425	0.425	0.433	0.433	0.433	0.433
20	0.360	0.941	0.941	0.941	0.938	0.425	0.425	0.425	0.425	0.441	0.425	0.433	0.433
21	0.380	0.941	0.941	0.941	0.934	0.425	0.425	0.425	0.425	0.441	0.425	0.433	0.433
22	0.400	0.941	0.926	0.941	0.934	0.425	0.425	0.425	0.425	0.425	0.425	0.425	0.433
23	0.420	0.926	0.926	0.926	0.926	0.425	0.425	0.425	0.425	0.425	0.425	0.425	0.433
24	0.440	0.926	0.941	0.926	0.926	0.425	0.425	0.425	0.425	0.425	0.425	0.425	0.433
25	0.460	0.941	0.941	0.941	0.433	0.425	0.425	0.425	0.425	0.425	0.425	0.425	0.433
26	0.480	0.941	0.946	0.941	0.433	0.425	0.425	0.425	0.425	0.425	0.425	0.425	0.430
27	0.500	0.941	0.946	0.941	0.433	0.425	0.425	0.425	0.425	0.425	0.425	0.425	0.430
28	0.520	0.946	0.946	0.946	0.433	0.425	0.425	0.425	0.422	0.425	0.422	0.422	0.430

Figure 7.15: An Example of Exported C-Scan Data Without Color.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1		0.0000	0.0200	0.0400	0.0600	0.0800	0.1000	0.1200	0.1400	0.1600	0.1800	0.2000	0.2200
2	0.000	53.6140	53.6140	60.6400	67.6600	76.6800	86.7000	96.7200	106.7400	116.7600	126.7800	136.8000	146.8200
3	0.020	45.9650	53.6140	60.6400	62.1270	76.6800	86.7000	96.7200	106.7400	116.7600	126.7800	136.8000	146.8200
4	0.040	38.3160	53.6140	60.6400	67.6600	76.6800	86.7000	96.7200	106.7400	116.7600	126.7800	136.8000	146.8200
5	0.060	30.6670	53.6140	60.6400	67.6600	76.6800	86.7000	96.7200	106.7400	116.7600	126.7800	136.8000	146.8200
6	0.080	23.0180	53.6140	60.6400	67.6600	76.6800	86.7000	96.7200	106.7400	116.7600	126.7800	136.8000	146.8200
7	0.100	15.3690	53.6140	60.6400	67.6600	76.6800	86.7000	96.7200	106.7400	116.7600	126.7800	136.8000	146.8200
8	0.120	7.7200	53.6140	60.6400	67.6600	76.6800	86.7000	96.7200	106.7400	116.7600	126.7800	136.8000	146.8200
9	0.140	0.0710	53.6140	60.6400	67.6600	76.6800	86.7000	96.7200	106.7400	116.7600	126.7800	136.8000	146.8200
10	0.160	72.3380	68.5100	73.1890	77.8700	82.5510	87.2320	91.9130	96.5940	101.2750	105.9560	110.6370	115.3180
11	0.180	64.6790	68.5100	72.3380	77.8700	82.5510	87.2320	91.9130	96.5940	101.2750	105.9560	110.6370	115.3180
12	0.200	57.0200	68.5100	66.3620	72.3380	77.8700	82.5510	87.2320	91.9130	96.5940	101.2750	105.9560	110.6370
13	0.220	49.3610	68.5100	64.2140	70.2200	75.7600	80.5000	85.2400	89.9800	94.7200	99.4600	104.2000	108.9400
14	0.240	41.7020	68.5100	62.0660	68.1020	73.6420	78.3820	83.1220	87.8620	92.6020	97.3420	102.0820	106.8220
15	0.260	34.0430	68.5100	60.0180	66.0180	71.5580	76.2980	81.0380	85.7780	90.5180	95.2580	100.0000	104.7400
16	0.280	26.3840	68.5100	58.0180	64.0180	69.5580	74.2980	79.0380	83.7780	88.5180	93.2580	98.0000	102.7400
17	0.300	18.7250	68.5100	56.0180	62.0180	67.5580	72.2980	77.0380	81.7780	86.5180	91.2580	96.0000	100.7400
18	0.320	11.0660	68.5100	54.0180	60.0180	65.5580	70.2980	75.0380	79.7780	84.5180	89.2580	94.0000	98.7400
19	0.340	3.4070	68.5100	52.0180	58.0180	63.5580	68.2980	73.0380	77.7780	82.5180	87.2580	92.0000	96.7400
20	0.360	0.0000	68.5100	50.0180	56.0180	61.5580	66.2980	71.0380	75.7780	80.5180	85.2580	90.0000	94.7400
21	0.380	72.3380	68.5100	58.0180	64.0180	69.5580	74.2980	79.0380	83.7780	88.5180	93.2580	98.0000	102.7400
22	0.400	64.6790	68.5100	56.0180	62.0180	67.5580	72.2980	77.0380	81.7780	86.5180	91.2580	96.0000	100.7400
23	0.420	57.0200	68.5100	54.0180	60.0180	65.5580	70.2980	75.0380	79.7780	84.5180	89.2580	94.0000	98.7400
24	0.440	49.3610	68.5100	52.0180	58.0180	63.5580	68.2980	73.0380	77.7780	82.5180	87.2580	92.0000	96.7400
25	0.460	41.7020	68.5100	50.0180	56.0180	61.5580	66.2980	71.0380	75.7780	80.5180	85.2580	90.0000	94.7400
26	0.480	34.0430	68.5100	48.0180	54.0180	59.5580	64.2980	69.0380	73.7780	78.5180	83.2580	88.0000	92.7400
27	0.500	26.3840	68.5100	46.0180	52.0180	57.5580	62.2980	67.0380	71.7780	76.5180	81.2580	86.0000	90.7400
28	0.520	18.7250	68.5100	44.0180	50.0180	55.5580	60.2980	65.0380	69.7780	74.5180	79.2580	84.0000	88.7400
29	0.540	11.0660	68.5100	42.0180	48.0180	53.5580	58.2980	63.0380	67.7780	72.5180	77.2580	82.0000	86.7400

Figure 7.16: An Example of Exported C-Scan Data with Colors.

	A	B	C	D
1	Statistics Results for Ch=1 Gate =1AMP			
2				
3	Overall Results			
4	Max(%)	Min(%)	Average(% Std. (%)	
5	99.573	22.552	81.393	29.58
6				
7	Distribution Results			
8	0.000 -6.250	0		
9	6.250 -12.500	0		
10	12.500 -18.750	0		
11	18.750 -25.000	6.5		
12	25.000 -31.250	8.9		
13	31.250 -37.500	4.2		
14	37.500 -43.750	1.9		
15	43.750 -50.000	2.2		
16	50.000 -56.250	1.5		
17	56.250 -62.500	0.9		
18	62.500 -68.750	0.7		

Figure 7.17: An Example of Exported Statistics Table.

7.4.2 Data/Graph to Microsoft Word

To export UTwin graph, first select the graph (clicking it), then select "To Word" to activate the "Export To Word" dialog. Figure 7.18 shows the Export to Word dialog. At the left top of this dialog, there is an "Export to Word" radio buttons group, select the item you want to export. Two types of item can be exported:

- Image of this page:** bitmap of the whole page.
- Image of this graph:** bitmap of the graph.

In the "Figure Caption" and "Figure Description" edit boxes, you can input the figure caption and description. The caption will be exported at the bottom of the graph. The description will be exported after the figure caption. If the 'Export annotations' has been enabled, all annotations inside this graph will be exported. The size, position and text of annotations will be exported.

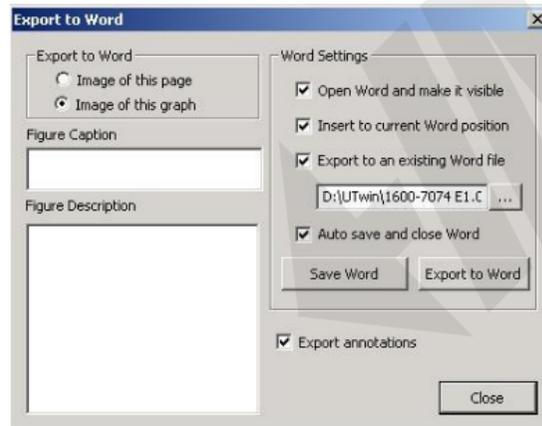


Figure 7.18: UTwin to Word Configuration Dialog.

In the 'Word Settings' group, there are several options:

Open Word and make it visible: check this box to make the Microsoft Word program visible.

Insert to current Word position: if checked, the graph and text will be inserted in the current cursor position in the Word document.

Export to an existing Word file: if checked, the graph and text will be exported into the existing Word document.

Auto save and close Word: if checked, Word will be automatically closed when closing this dialog.

Click 'Export to Word' button to start exporting.
Click 'Save Word' button to save the Word document to a file.

Figure 7.19 shows an example of exported C-Scan graph with comments and annotations.

Tables such as statistics and clustering tables can be exported to Word Excel also. The tables will automatically be converted to Word tables.

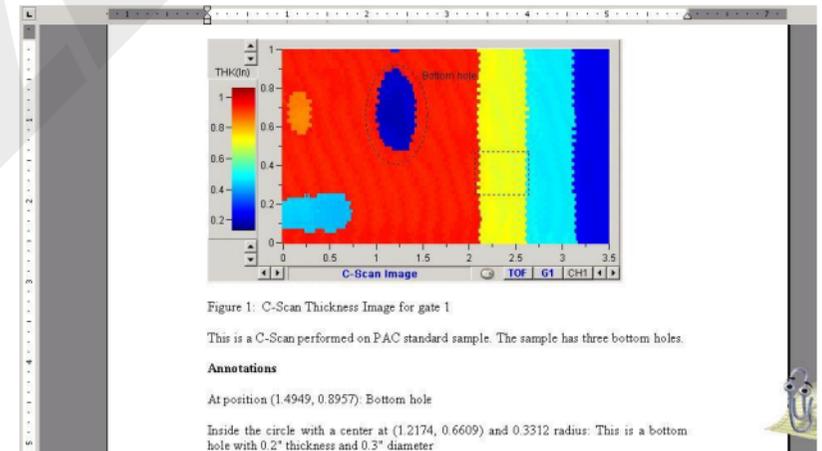


Figure 1: C-Scan Thickness Image for gate 1

This is a C-Scan performed on PAC standard sample. The sample has three bottom holes.

Annotations

At position (1.4949, 0.8957): Bottom hole

Inside the circle with a center at (1.2174, 0.6609) and 0.3312 radius: This is a bottom hole with 0.2" thickness and 0.3" diameter

Figure 7.19: Example of an Exported C-Scan Graph with Comments and Annotations

7.4.3 Automatic Report Builder Option

Beside exporting graphs to Word one by one, UTwin provides an automatic report generator to let you organize a report and export the whole report. Figure 7.20 shows the automatic report generator. The table in the report generator lists all the sections, figures and tables in the report. At the bottom of the table, there are several buttons provided for editing the report. With these buttons, you can add and remove figures from the report; change the

figure sequence. A figure is specified by its page name (the page where the figure locates) and its internal name. For each figure, you can input its caption and comment. You can specify the report's header and footer in the edit boxes or using an existing report template. After you have organized these figures in the report, you can click the Generate a New Report button to export the whole report to a Word document.



During exporting, please don't perform any other tasks on the computer. Let the program finish the exporting process since the program needs to capture the screen image during report generation.

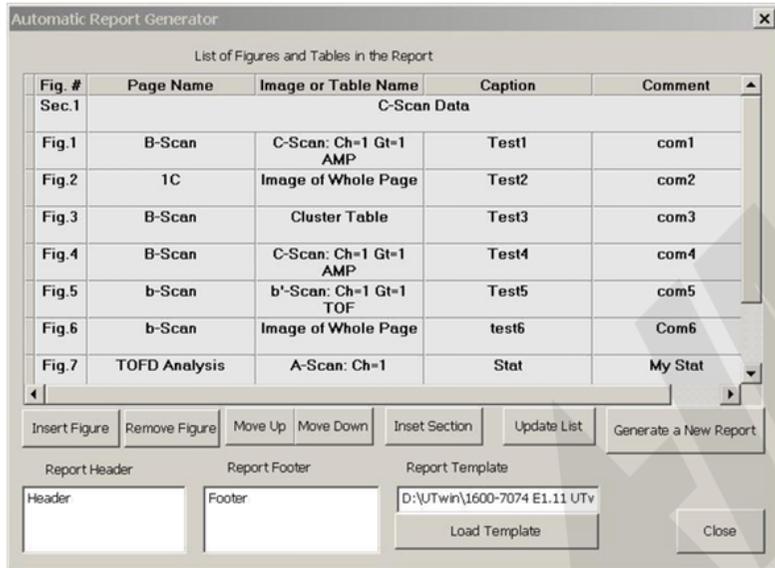


Figure 7.20: Configuration for Full Report Builder.

7.5 Time-Of-Flight Diffraction (TOFD) Option

7.5.1 Introduction

UTwin™ Version E1.08 and above offer Time-of-Flight-Diffraction (TOFD) as an option. The TOFD has proved to be a powerful, fast, crack detection (and sizing) tool in ultrasonic nondestructive testing.

To start TOFD inspection, clicking on the TOFD Icon  in the UTwin main toolbar or selecting from the main menu

Configure Inspection Mode TOFD

After you have selected the TOFD inspection mode, the TOFD analysis control bar will become visible as shown in Figure 7.20.

7.5.2 TOFD Settings

On the left side of the standard TOFD user interface (shown in Figure 7.21) is a control bar for TOFD settings. In this control bar, the following setup and control parameters are available:

Channels: select from the drop list the channel number for editing.

Scan Mode: select the relation between the scanning direction and the beam axis (the plane defined by the two TOFD probes). B-Scan mode represents that the scanning axis parallel to the beam axis and the D-Scan mode represents the scanning axis perpendicular to the beam axis

Surface Shape: select the part shape. The flat surface is currently the default selection.

TOFD Geometry: click this button to open the "TOFD Settings" dialog as shown in Figure 7.22. Within the "Sample Properties" group in this dialog, you can change sample thickness for flat samples and specify inner and outer radius for cylindrical samples. In the "Probe Properties" group, you can change the "Probe center separation (PCS)" and probe diameter. Click the "Material" and "Probe" to input additional material and probe properties, which have been discussed in section 3.3.3.5 and 3.3.3.6.

TOFD Diagram: click this button to create the TOFD graph as shown in Figure 7.23. If TOFD graph has already been created, click this button to update the graph. The TOFD diagram is a view which shows the simulated waveform, probe location, coverage and defect location. At the top of this diagram there is a simulated TOFD waveform graph. The TOFD waveforms are simulated based on wedge delay, wedge angle, probe frequency, PCS, sample thickness and location of the defect. The location of lateral wave and back wall reflection are indicated by "La" and "BW" respectively on the horizontal axis. The locations of the diffracted waves from the top and bottom tips of the defect are indicated by "C0" and "C1" respectively. This simulated waveform may be helpful in interpreting the A-Scan waveform. The calculated TOFD coverage is displayed as a color-coded image in the bottom graph. The coverage is calculated based on probe diameter, angle, center frequency and PCS. The red lines at the bottom of the graph indicates the defect location for the selected reflection in the A-Scan or B-Scan graph. Select the "Graph Setup" to open the TOFD Graph Setup dialog as shown in Figure 7.24. In the "Display" group, check the "Display simulated TOFD waveform" to show or hide the simulated waveform; check the "Display graph caption" to show or hide the graph captions. In the "TOFD waveform simulation" group, you can input the depth and size of the defect for simulation. The values of depth and size are given as a percentage of the sample thickness. In the "TOFD coverage simulation" group, you can specify the color for each given dB range in the coverage display.

Other items in the control bar are related to TOFD image analysis and defect sizing. These functions will be discussed in the following TOFD analysis section.

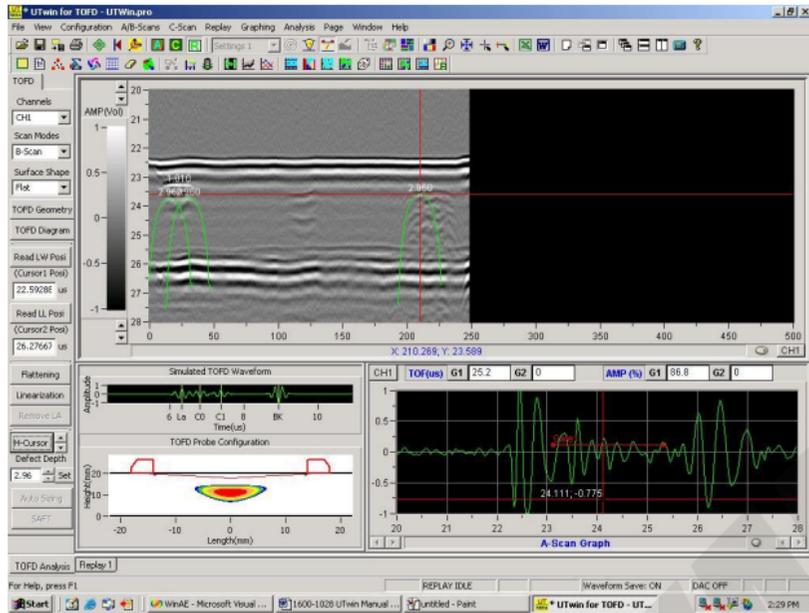


Figure 7.21: Standard TOFD Analysis User Interface.

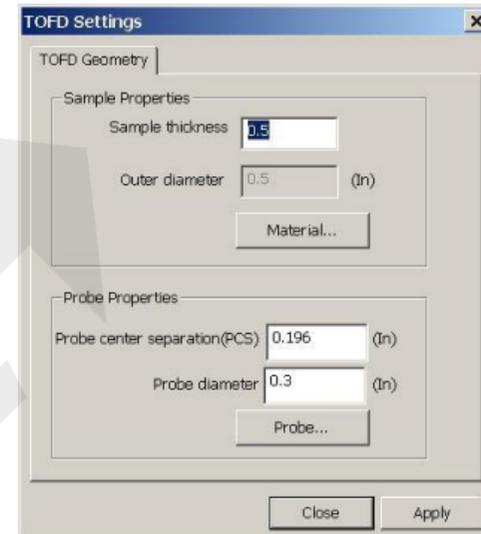


Figure 7.22: TOFD Geometry Settings.

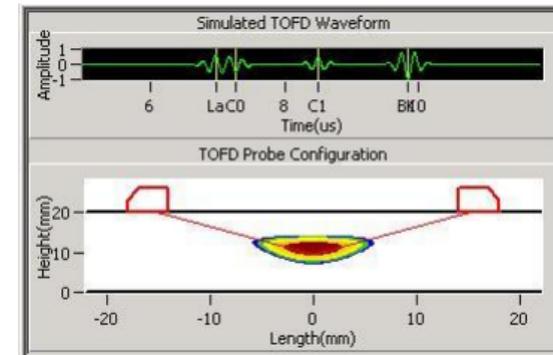


Figure 7.23: TOFD Graph which includes Simulated Waveform (top graph), Probes , Simulated Coverage (color image inside the bottom graph) and depth indicator (red lines at bottom graph).

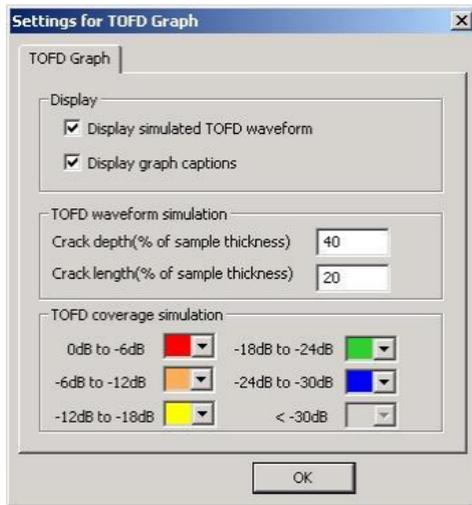


Figure 7.24: TOFD Graph Setup.

7.5.3 TOFD Data Acquisition

When the setup is done, you are ready to do the acquisition. The recommended TOFD user interface is shown in Figure 7.21. The top graph is a B-Scan image and the right bottom graph is an A-Scan graph. The procedure to perform TOFD acquisition is identical with that for B-Scan mode acquisition discussed in section 4. Follow the discussion in section 4.7.1 to setup B-Scan acquisition settings and perform a test.

7.5.4 TOFD Analysis

UTwin provides many tools to process TOFD images and locate defects.

7.5.4.1 TOFD Probe Coverage and Waveform Simulation

As discussed in previous section, the TOFD diagram shows both the simulated waveform and coverage based on your current settings. These are tools for you to select the right probes and setup the right probe separation.

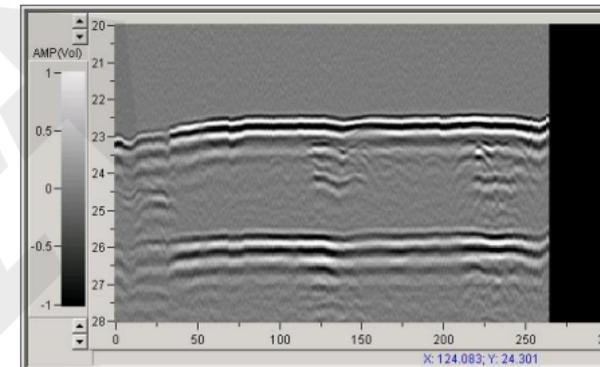
7.5.4.2 TOFD Image Flattening

In some inspection cases, due to variation of the (water) coupling length, there is a variation in signal timing along the scanning line, which produces a distorted TOFD image. This effect is illustrated in Figure 7.25(a). UTwin provides a tool to flatten the image based on your selected signal. To flatten the TOFD image, you first need to define the lateral wave position. To define lateral and back wall positions:

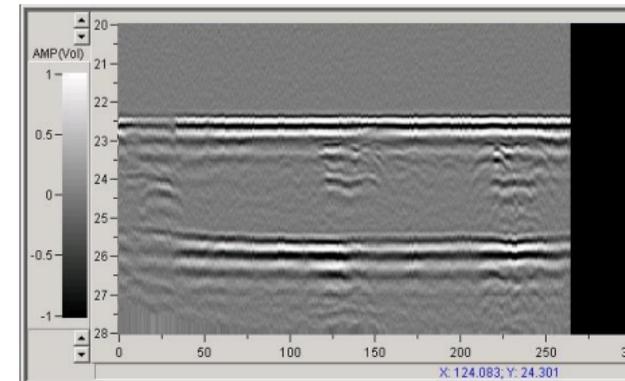
- STEP 1: click the A-Scan graph and enable measurement cursors (show two cursors).
- STEP 2: move the first cursor (red color) to the lateral wave position.
- STEP 3: click "Read LW Posi" button in the TOFD control bar. The acquired value will be shown in the edit box under the button.

STEP 5: click "Read LL Posi" button in the TOFD control bar. The acquired value will be shown in the edit box under the button.

After the lateral wave position has been defined, flatten the TOFD image, by selecting the image and clicking the "Flattening" button. If the TOFD image has already been flattened, click the "Flattening" button to restore the original image. Figure 25(b) shows an example of TOFD image after flattening operation.



(a)



(b)

Figure 7.25: (a) TOFD Image Before Flattening. Signal timing varies along the undulating scanning surface (b) TOFD image after flattening. The variation in signal time has been removed using the lateral wave position.

7.5.4.3 TOFD Image Linearization

In TOFD inspection, the signal arrival time of a defect has a nonlinear relation with the defect depth. That means a diffracted signal at the middle of the lateral wave and the back wall reflection doesn't mean that the defect is located at the center of the sample. To provide straightforward interpretation of the TOFD image, UTwin provides a linearization tool to make the sound path axis in the B-Scan image linearly related to the defect depth. The procedure to perform linearization is similar to the flattening operation discussed in the previous section. After the lateral wave and back wall positions have been defined, select the B-Scan graph and click the "Linearization" button. If the sound path in the B-Scan graph is not displayed as distance (or depth), you may also want to open the B-Scan graph setup dialog and select depth as the displaying option for the sound path axis. Figure 7.26 shows an example of the TOFD image after flattening and linearization. The vertical axis (sound path axis) is displayed as depth. After linearization, you can directly read the defect depth based on the depth axis as shown in the vertical axis in Figure 7.26.

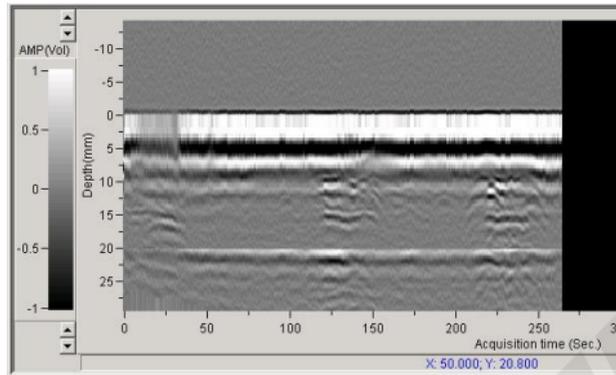


Figure 7.26: TOFD image after flattening and linearization.

7.5.4.4 Defect Location

Besides the TOFD image linearization which provides a clear indication of the defect depth, UTwin provides several other methods to help you in locating defects.

A: Defect location with cursors

With the TOFD diagram visible, you can locate defect depth by moving the cursor in the A-Scan or B-Scan graph. Figure 7.27 shows an example of defect location using a cursor in the A-Scan graph. Using your mouse to move the cursor over the defect signal, the defect indicator (two red lines) in the TOFD diagram will automatically indicate where the reflection comes from. Similarly you can move the cursor in the B-Scan graph.

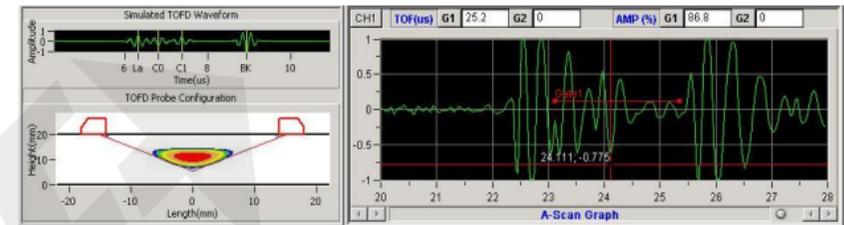


Figure 7.27: Defect Locating with A-Scan Cursor. The cursor in A-Scan points to a defect signal (right) and the corresponding defect location is shown in the TOFD diagram (left).

B: Defect location by arc fittings

In TOFD inspection, the time-of-flight of a defect varies with the probe position along the scanning line. When the defect lies in the middle plane of the two probes, the time-of-flight is a minimum. When the defect moves away from the middle plane, the traveling distance will increase and the defect signal will arrive later. The relation between signal arrival time and the defect position forms a unique-shaped curve (TOFD arc) for a given depth and probe separation. Once the probe separation is known, the TOFD arc depends only on defect depth. Thus by fitting the TOFD arc, the defect depth can be determined. To locate defect depth with arc fitting do the following:

- STEP 1: Select the B-Scan graph and enable one cursor.
- STEP 2: Click "H-Cursor" button in the TOFD control bar to enable arc fitting. If arc fitting has already been enabled, clicking this button will disable arc fitting.
- STEP 3: Move the cursor in the selected B-Scan to the defect position.
- STEP 4: Change the defect depth using the "Defect Depth" spin button (UP, Down) or the "Defect Depth" edit box in the TOFD control bar. As the depth changes, the shape of the hyperbolic cursor will be updated based on the depth value. Change the depth setting until you get a good fit between the TOFD arc and the hyperbolic cursor.
- STEP 5: Click "Set" to finalize the fitting. The depth is shown on the top of the hyperbolic cursor.
- STEP 6: Go back to STEP 3 to measure another defect.

You can use the Up-Down Arrow buttons next to the "H-Cursor" to change the size of the hyperbolic cursor. Determining Defect location by this arc fitting method does not need the lateral wave and back wall positions defined. Figure 7.28 shows an example of defect location with arc fitting.

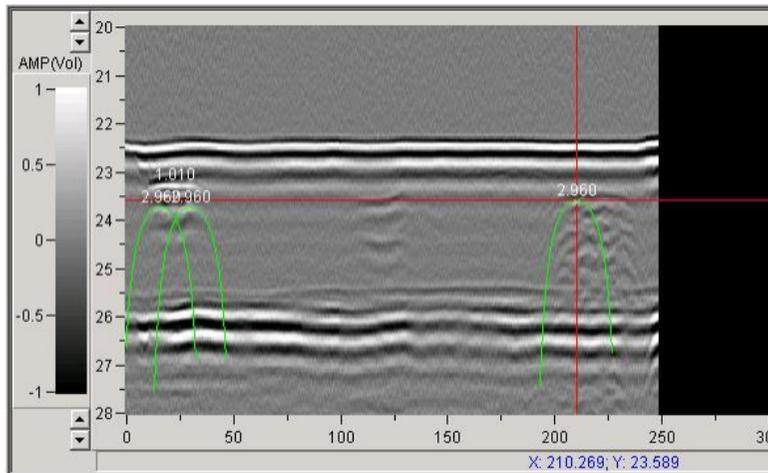


Figure 7.28: Defect Location with Arc Fitting. Three hyperbolic cursors are overlaid with the TOFD image. The depth of the defect is shown on the top of the hyperbolic curve.

7.6 Welding Inspection Option

7.6.1 Introduction

UTwin™ Version E1.19 and higher integrated Weld Inspection Option. The welding inspection option uses one or two angled sensors (channels) in Pulse/Receive mode to perform a C-Scan type weld inspection.

To start Weld inspection, clicking on the Weld Icon  in the UTwin main toolbar or selecting from the main menu

Configure Inspection Mode Weld Inspection

After you have selected the Welding inspection mode, the Welding Inspection control bar will become visible as shown in Figure 7.29.

7.6.2 Welding Inspection Settings

Once Welding Inspection has been enabled, on the left side of the screen (shown in Figure 7.29) is a weld inspection control bar. In this control bar, the following setup and control parameters are available:

Weld Line: select the relation between the welding center line and motion axis. If X-axis is selected, then Y-axis will be considered to be perpendicular to the welding line; if Y-axis is selected, X-axis becomes perpendicular to the

welding line. If T axis is selected, Z-axis is considered to be perpendicular to the welding center line. You need to setup this parameter correctly based on your sample alignment.

Weld Posi.: define the location of the welding line. Once welding center line and welding position have been defined, the spatial relation between the sensor and weld can be determined based on current motor positions.

Weld Width: width of the weld.

Weld Geometry: click this button to open the “Welding Settings” dialog shown in Figure 7.30. Within the “Sample Properties” group in this dialog, you can change sample thickness for flat samples and specify outer diameter for cylindrical samples. In the “Probe Properties” group, you can change the probe diameter. Click the “Material” and “Probe” to input additional material and probe properties, which have been discussed in section 3.3.3.5 and 3.3.3.6.

Weld Diagram: click this button to create the Weld graph as shown at the bottom of Figure 7.29. If Weld graph has already been created, click this button to update the graph based on current motor positions and settings. The Weld diagram is a view which outlines the weld geometry (red line) and probe location and shows simulated sound beam. The sound beam is calculated based on probe diameter, angle, center frequency. The result is presented as a gray-level image based on the sound intensity and overlapped with the weld geometry based on current motor position and weld location. The green line within the simulated sound beam indicates the center of the sound beam. The color lines at the middle of the graph indicate the gate location. Select the “Graph Setup” to open the Weld Graph Setup dialog as shown in Figure 7.31. In the “Display” group, check the “Display simulated beam” to show or hide the simulated sound beam; check the “Display graph caption” to show or hide the graph captions; check ‘Display gate location’ to show or hide these lines indicating gate location. In the “Beam coverage simulation” group, you can specify the color for each given dB range for the sound beam display.

Show Leg: check this box to show or hide these vertical straight lines shown in A-scan graph (see the blue lines in A-scan graph in Figure 7.29). These straight lines indicate the leg position (top and back surface).

Other items in the control bar are related to Weld image analysis and defect sizing. These functions will be discussed in the following Weld analysis section.

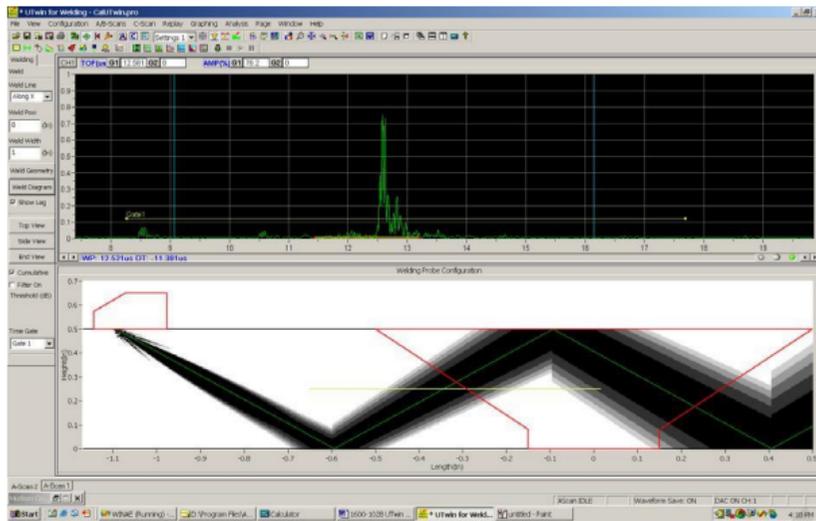


Figure 7.29: Welding Inspection User Interface in A-Scan mode.



Figure 7.30: Welding Settings dialog.

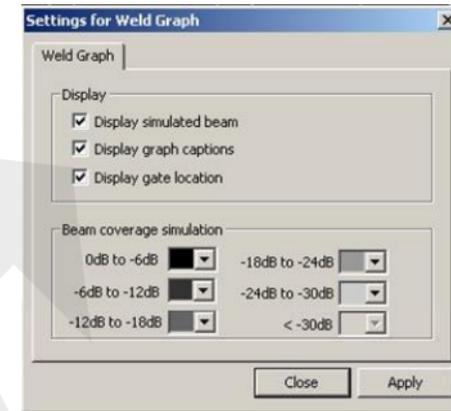


Figure 7.31: Weld Graph Setup.

7.6.3 Projected Views in Welding Inspection

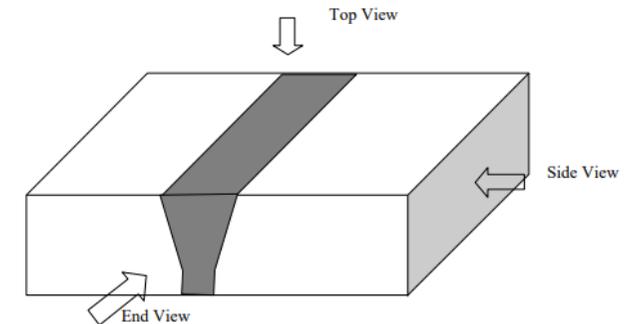


Figure 7.32: Projected Views in Weld Inspection.

UTwin provides projected view (top, side and end views) to intuitively present the geometry (location and size) of defects. The three project planes are shown schematically in Figure 3.32. Top View is an angle-corrected C-scan image created from the project of C-scan data onto the horizontal plane. This view shows the defect's x-y positions and length and is analogous to radiographic film. The B-Scan Side view is created from the gated waveform data in the weld onto the vertical plane along the weld line. The side view shows the depth of defects. The B-Scan End view is created from the gated waveform data in the weld onto the vertical plane perpendicular to the center line. This view shows the orientation of a defect.

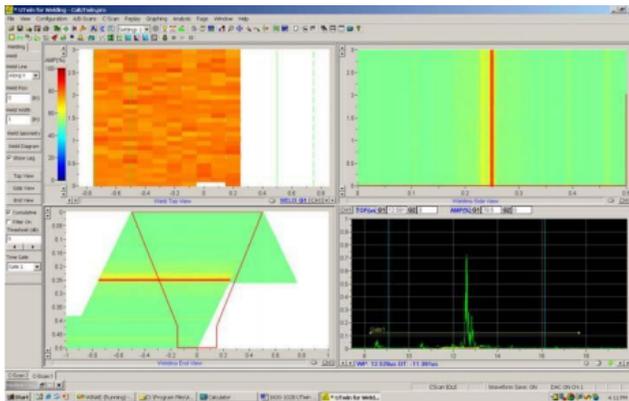


Figure 7.33: Welding Inspection User Interface in real-time C-scan mode.

This graph Figure 7.33 shows the standard user interface in real-time C-scan mode. The top left graph is a top view C-scan image. To create a top view, select a C-scan graph (click it) and then click the 'Top View' button in the weld control bar. A C-scan graph in top view mode will show "Weld Top View" in the information bar at the bottom of the graph. Click the 'Top View' button again to switch the C-scan graph back to normal display mode. The solid vertical lines in the top view graph indicate the weld width (weld boundaries) and dash line indicates heat effect

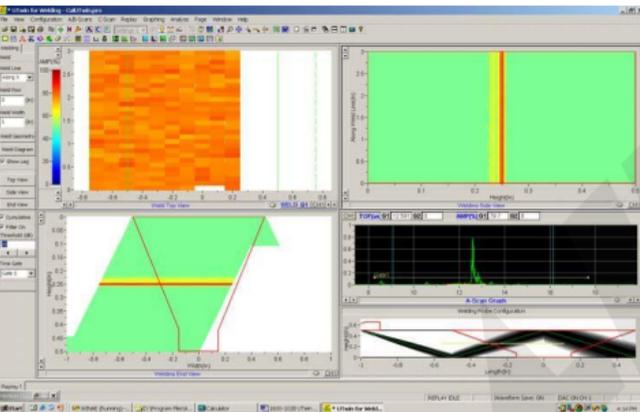


Figure 7.34: Welding Inspection User Interface in replay mode.

zone (1/4 inch wider). The top right graph is the side view B-scan image. The left bottom graph is the end view B-scan image. To create side and end views, select a B-scan graph and click 'Side View' or 'End View' button in the weld control bar. Click these buttons again to switch B-scan graph back to normal display mode. The weld geometry is indicated by red lines in these graphs. The right bottom graph is A-scan.

Figure 7.34 shows the standard user interface in replay mode. In this mode, it is useful to add a weld graph (at the right bottom) to show the sound beam. When you change the cursor position in C-scan graph, the weld graph will be automatically updated based on scanning and index positions at the cursor point. There is a red star point along the sound beam which indicates the exact location where the (defect) reflection comes from. For side and end views, there are few more parameters in the weld control bar can be modified

Cumulative: When plot side or end view, multiple data can be displayed on the same image pixel. Check this box if you want to display the data with max amplitude. If this is unchecked, only the waveform data along current cursor line will be displayed.

Filter On: This function is useful for removing noise in the side and end views. If checked, data with amplitude below the given threshold will be considered as 0.

Threshold(dB): Define the threshold for the filter function.

Time Gate: Select the waveform range to be displayed in the side and top views.

7.7 Advanced Features Option

7.7.1 Using Advanced Features

Besides the conventional AMP and TOF gate features, UTwin offers many advanced gate features. You can use these features in A-, B- and C-Scans the same way as you use AMP and TOF gates features. To use advanced features, in the gate settings dialog shown in Figure 4.5, simply select an advanced feature for any gates from the ADV dropdown list. Figure 7.35 shows an A-Scan table view for advanced features. The advanced features are labeled with three capital letters, which you can find in the ADV droplist. To calculate these advanced features, some additional setting parameters may be required. You can configure these parameters by clicking the ADV settings button. The setting dialog for advanced features is shown in Figure 7.36.

	Gate1	Gate2	Gate3	Gate4
CH1	PHA:180.000	ATT:0.000	VEL:0.218	RIT:0.040

Gate Advanced Feature ADV

Figure 7.35: A-Scan Table View for Advanced Features.

Currently, the following advanced features have been implemented:

- 1). Phase Angle (PHA)
- 2). Phase Inversion (PHI)
- 3). Attenuation (ATT)
- 4). Correlation Thickness (CRR)
- 5). Rising Time (RIT)
- 6). Duration Time (DUT)
- 7). Energy (ENG)

7.7.2 Description of Advanced Features

Phase Angle (PHA)

The Phase Angle feature is the phase shift of the gated pulse compared with a standard Gaussian-shaped pulse or recorded reference pulse. You can configure the reference pulse from the setup dialog shown in Figure 7.36. To record a user-defined reference waveform as a zero phase signal, select 'User Defined Waveform' from the 'Waveform type' droplist, then adjust your sensor to obtain a nice waveform in the gate (or move your cursor in replay mode) and click 'Record current waveform as reference' button. To obtain a stable and accurate phase shift of a pulse within a gate, adjust the gate detect threshold just slightly above the noise level.

Phase Inversion (PHI)

The Phase Inversion, indicates the inversion of the gated pulse compared with a reference pulse. If the phase is inverted, the value is 1, otherwise the value is 0. Setup the reference waveform for this feature the same as that for phase angle feature. You can change the detection sensitivity using the 'consider as phase inversion when phase angle above' edit box in the setting dialog shown in Figure 7.36.

Attenuation (ATT)

The attenuation is calculated based on $A=e^{-\alpha w}$ using peaks within the gates, where α is the attenuation. To correctly find the peaks within the gate you need to specify the minimum separation between peaks as shown in Figure 7.36.

Velocity (VEL)

Velocity is calculated based on the TOF of the gate and sample thickness. You can specify the sample thickness in the advanced settings shown in Figure 7.36.

Correlation Thickness (CRR)

The thickness is calculated based on the maximum correlation position between gate I and gate I + 1. For example, if gate 1 has the correlation thickness feature enabled, then its value is the time (thickness) difference between gate 1 and gate 2 based on the correlation between the signals within these two gates.

Rising Time (RIT)

The elapsed time between the crossing gate threshold point and the maximum amplitude point within the gate.

Duration Time (DUT)

The elapsed time between the rising-edge crossing gate threshold point and the falling-edge crossing gate threshold.

Energy(ENG)

The energy is calculated as the summation of the absolute amplitude which is above threshold * number of point in the gate * sampling rate.

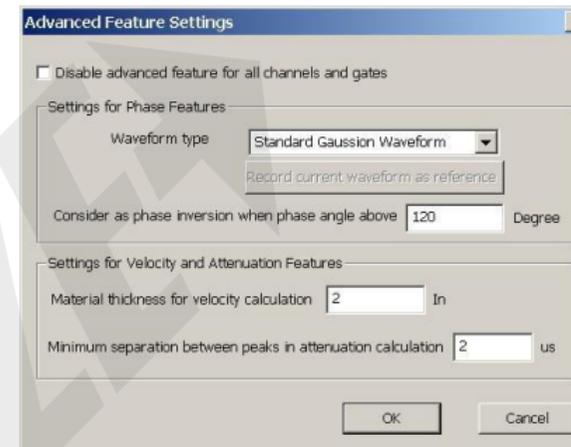


Figure 7.36: Settings for Advanced Features.



Disable advanced feature for all gates and channels if you do not want to use it because some features can significantly slow down the program!

8. EXAMPLES OF STANDARD USER INTERFACES IN UTwin

The following is a graphical list of recommended user screens for various inspection modes. All these user graph screens have been saved in the User Interface Library (see Section 3.3.1.6). You can recall them at any time by opening the User Interface Library dialog.

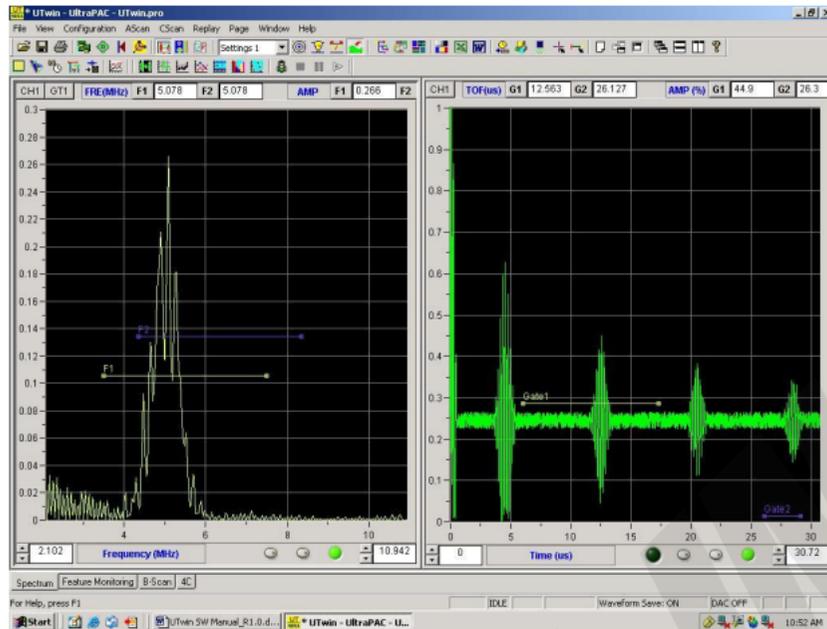


Figure 8.1: Spectrum Analysis User Interface (Left: Spectrum Graph, Right: A-Scan Graph).

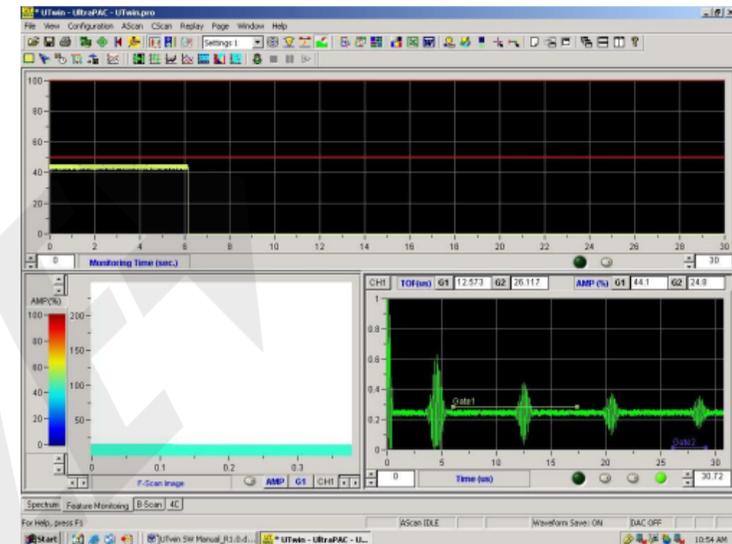


Figure 8.2: Feature Monitoring User Interface (Top: Feature Monitoring Graph, Bottom Left: Fc Image, Bottom Right: A-Scan Graph).

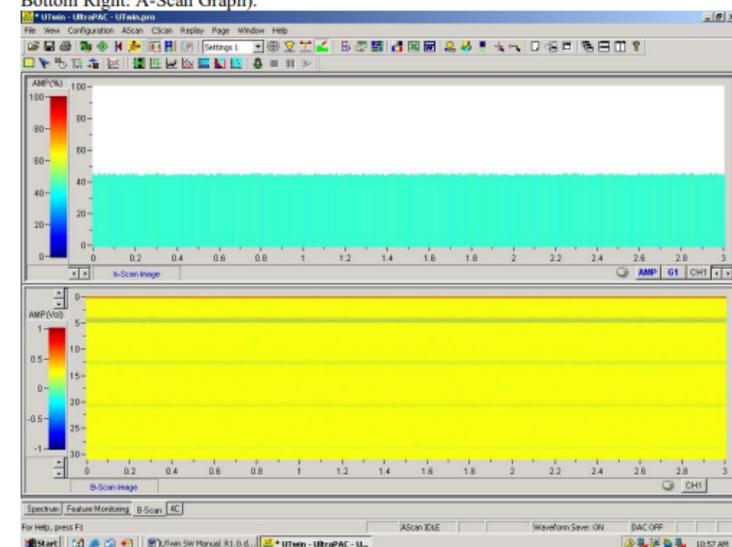


Figure 8.3: B-Scan User Interface (Top: b-Scan Image Graph, Bottom: B-Scan Graph).

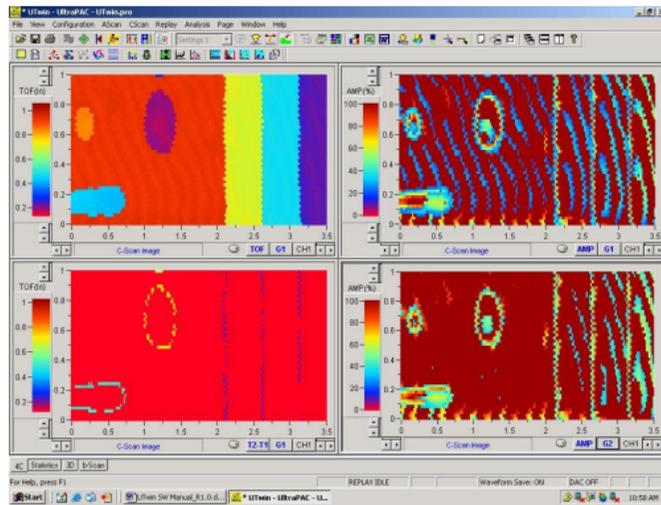


Figure 8.4: C-Scan User Interface (4 C-Scan Image Graphs).

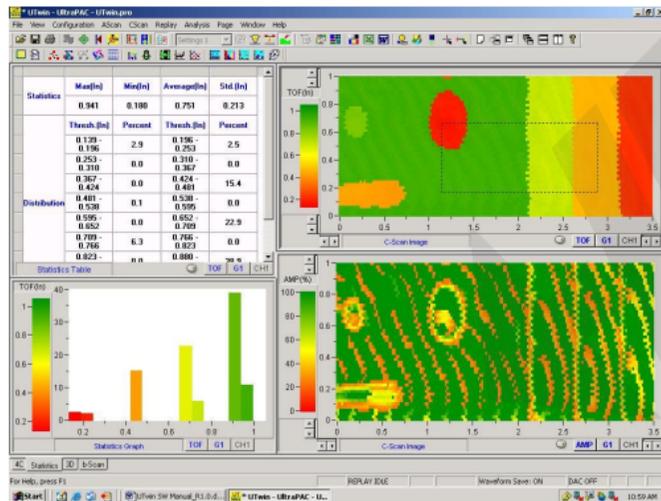


Figure 8.5: Statistics Analysis User Interface (Top Left: Statistics Table, Bottom Left: Statistics Histogram Graph, Top Right: C-Scan Image for analysis, Bottom Right: C-Scan Image Graph).

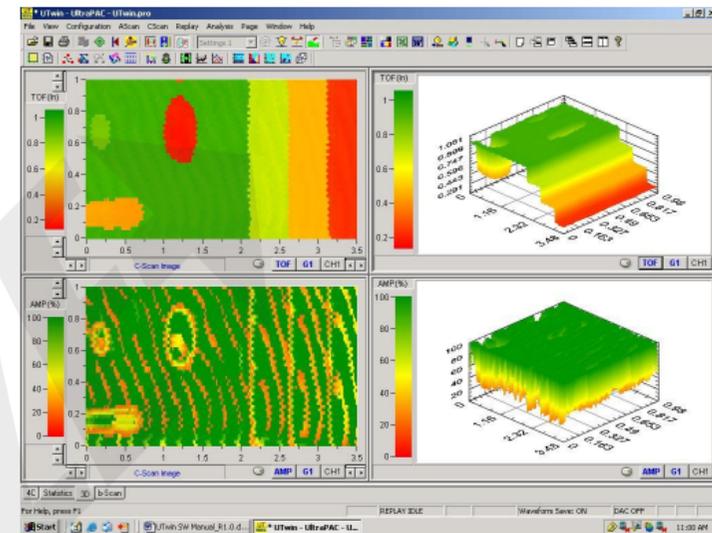


Figure 8.6: 3D and 2D C-Scan Image Graphs.

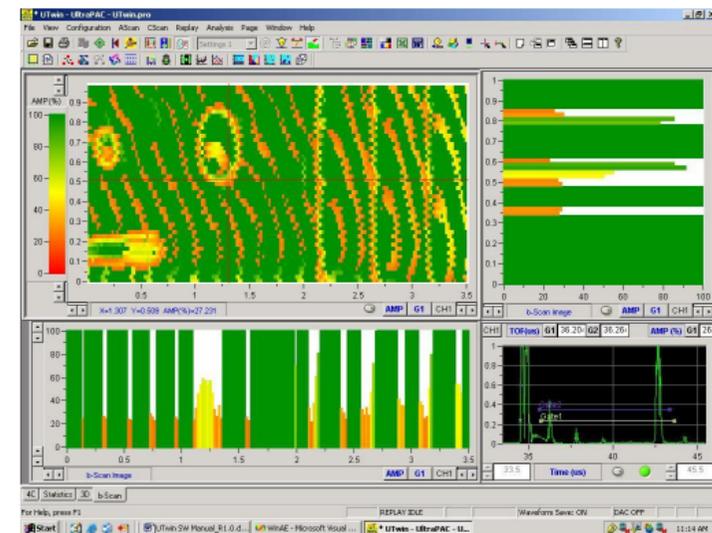


Figure 8.7: C-Scan Image, b-Scan image, b'-Scan Image and A-Scan Graphs.

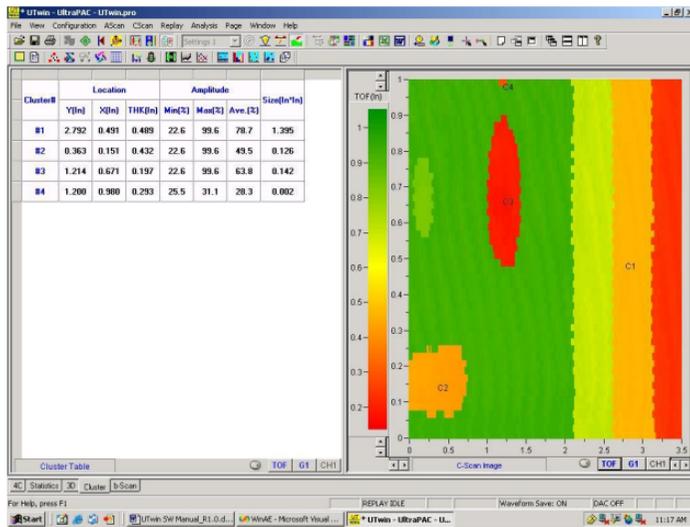


Figure 8.8: Cluster Analysis User Interface.

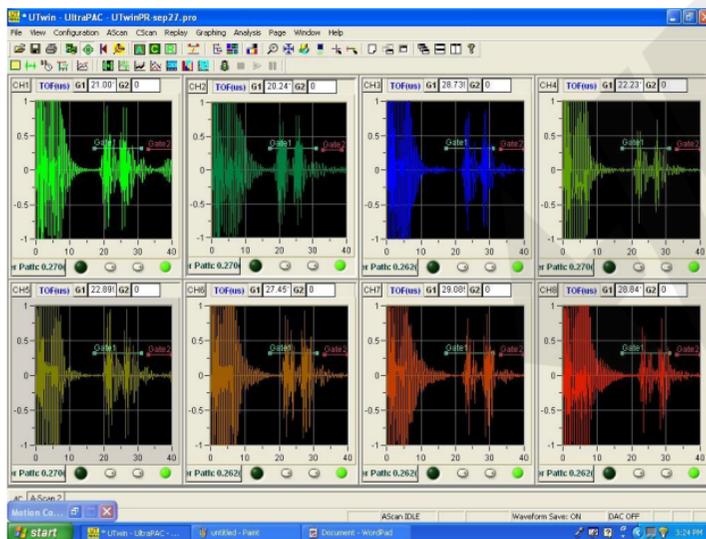


Figure 8.9: A-Scan Views with 8 Channels.

9. TURNKEY SYSTEMS

9.1 L.S.I Inspection Mode

UTwin is capable of controlling the LSI (Large Scale Inspection) system and providing all the same rich capabilities that are available in UTwin. To access the LSI setup configuration and operation, in the Main menu, select

Configure Inspection L.S.I

A message dialog will popup and ask you whether you want the program to automatically load the default settings for the L.S.I system. If you select YES, then your scanner will be configured based on our latest L.S.I crawler. These parameters are shown in Figure 9.1. If you are not using our latest L.S.I system, then you may need to check these parameters and manually change them.

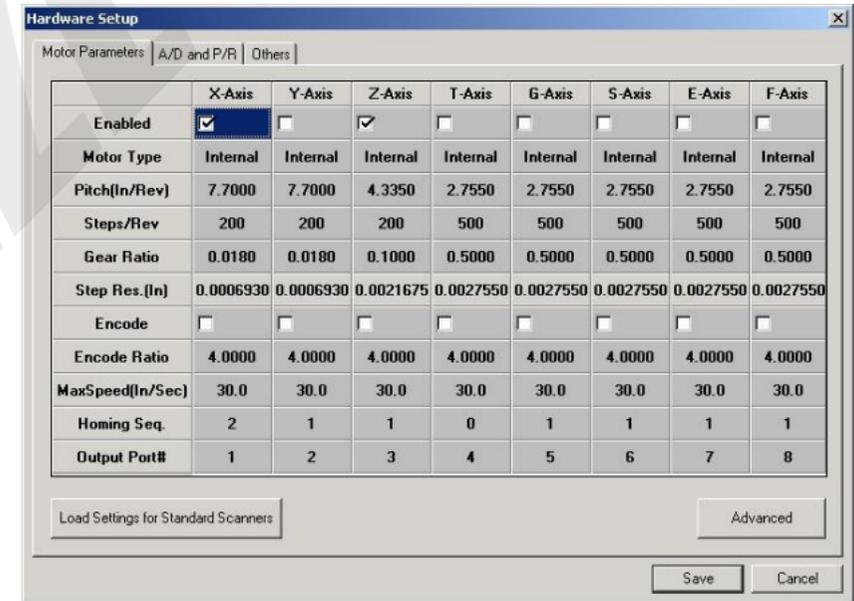


Figure 9.1: Scanner Parameters for L.S.I.

9.2 Cylinder Inspection Mode

UTwin cylinder inspection mode provides the state-of-the-art software tools for testing high pressure cylinders and vessels. UTwin cylinder inspection mode meets the entire DOT (Department of Transportation) requirements for testing high pressure cylinders using ultrasonic methods.

Only authorized personals are allowed to activate Cylinder Inspection Mode. Once this mode is activated, you will see that user interface for several dialogs have been tailored for this mode .

The motion jog bar will have several additional buttons for controlling rotation and water injection as shown at the bottom of Figure 9.2. Click 'Head Up' or 'Head Down' to pull up and down the ultrasonic head. Click 'Spin Off' or 'Spin On' to start or stop rotation. Click 'Water Off' or 'Water On' to start or stop water injection.

The flaw analysis function in this mode is almost the same as that described in Section 6.10. In this function, you can specify the DOT min thickness and DOT specification. For calibration projects, you can input serial#, manufacture and manufacture year for the calibration cylinder.

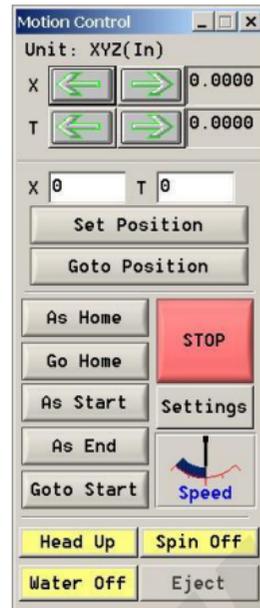
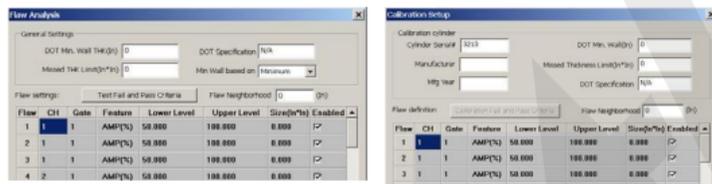


Figure 9.2: Motion jog bar in cylinder inspection mode.



(a)

(b)

Figure 9.3: Flaw Analysis in (a) testing mode and (b) calibration mode.

In 'Settings for C-Scan' dialog, for rotation axis, setup start position (usually is zero), cylinder diameter, circumferential resolution and speed. The spin speed is manually controlled by an external panel. Matching this speed with the actual speed makes the motion along index smoother. Similarly for index axis, you need to setup start position, length, resolution and speed. The 'Start Delay' time is the waiting time between starting water injection and C-scan. Setup appropriate Start Delay value to make sure all air bulbs in the coupling tube have been completely removed before data acquisition is started. Click 'Re-Calibrate' to load the calibration project and redo calibration.

When starting C-scan, a dialog, as shown in Figure 9.5, for inputting testing/calibration information will appear. In this dialog, click 'No More Test' button to cancel the test. If there are visual defects, click 'Visual Fail' to popup a list in which you can categorize the visual defect. If there is no visual defect, switch visual inspection from 'Fail' to 'Pass' and the 'Start Test' button will be enabled. Click this button to start UT test. All the inspection parameters can be pre-entered and saved in a table shown in Figure 9.6. During test, you only need to click 'Get Info from Table' to retrieve these parameters.



Figure 9.4: Settings for C-Scan in cylinder inspection mode.

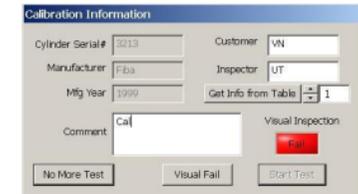


Figure 9.5: Calibration Information

Serial#	Manufacturer	Mfg Year	Comment	Customer	Inspector	
1	PX-2007-A1	Fiba	2006	cal	VW	LG
2	PX-2007-A2	Fiba	2003	test	AW	LG
3	PX-2007-A3	Fiba	2001	cal	AC	LG
4	PX-2007-A4	Fiba	2004	test	VW	LG
5						

Figure 9.6: Inspection information data table.

Once calibration/testing is done, flaw analysis will be automatically started. After analysis is done, inspection results are automatically displayed as shown in Figure 9.7. Click 'Invalid Test' to cancel and redo the test. Click 'Result Accepted' to accept the result and start next test. All results are printed out and saved in an inspection log file. In the main menu, select Analysis->Inspection Log to open the inspection log dialog (Figure 9.8) to view the results.



Figure 9.7: Inspection Results.

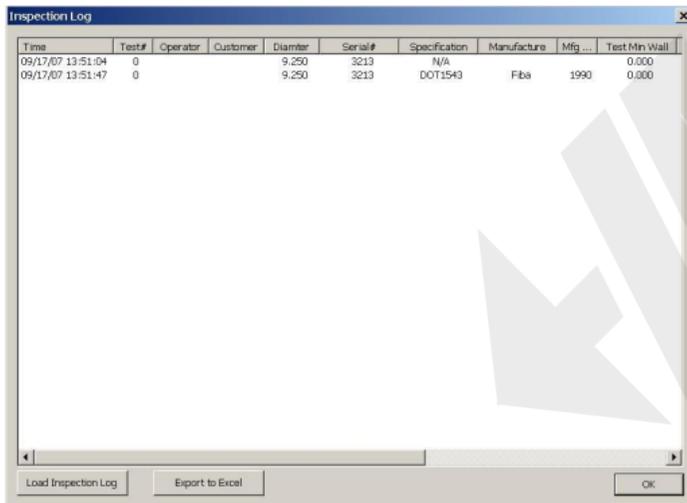


Figure 9.8: Inspection Log

9.3Bar Rotator and Turn Table Inspection Mode

In the Hardware Setup dialog (Figure 3.21), click 'Bar Rotator' to activate bar rotator mode (only authorized personals can activate this mode). In the Bar Rotator Settings dialog, check the 'T-Axis is bar rotator axis' to activate bar rotator inspection mode. Input the rotator diameter. The sample diameter can also be entered in this dialog (it can also be specified in the C-scan Settings dialog).

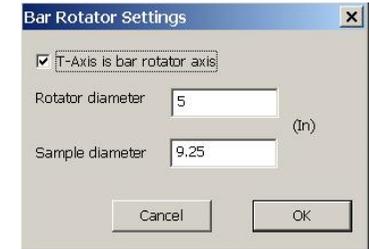


Figure 9.9: Activate Bar Rotator.

The Settings for C-Scan dialog is shown in Figure 9.10. In this dialog, you specify parameters for scanning and index axes and input the sample diameter. The resolution for the rotation axis can be specified either as degree or circumferential length.

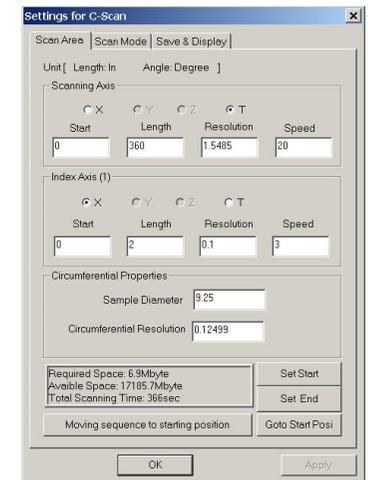


Figure 9.10: Settings for C-Scan in bar rotator/turn table mode.